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ABSTRACTS
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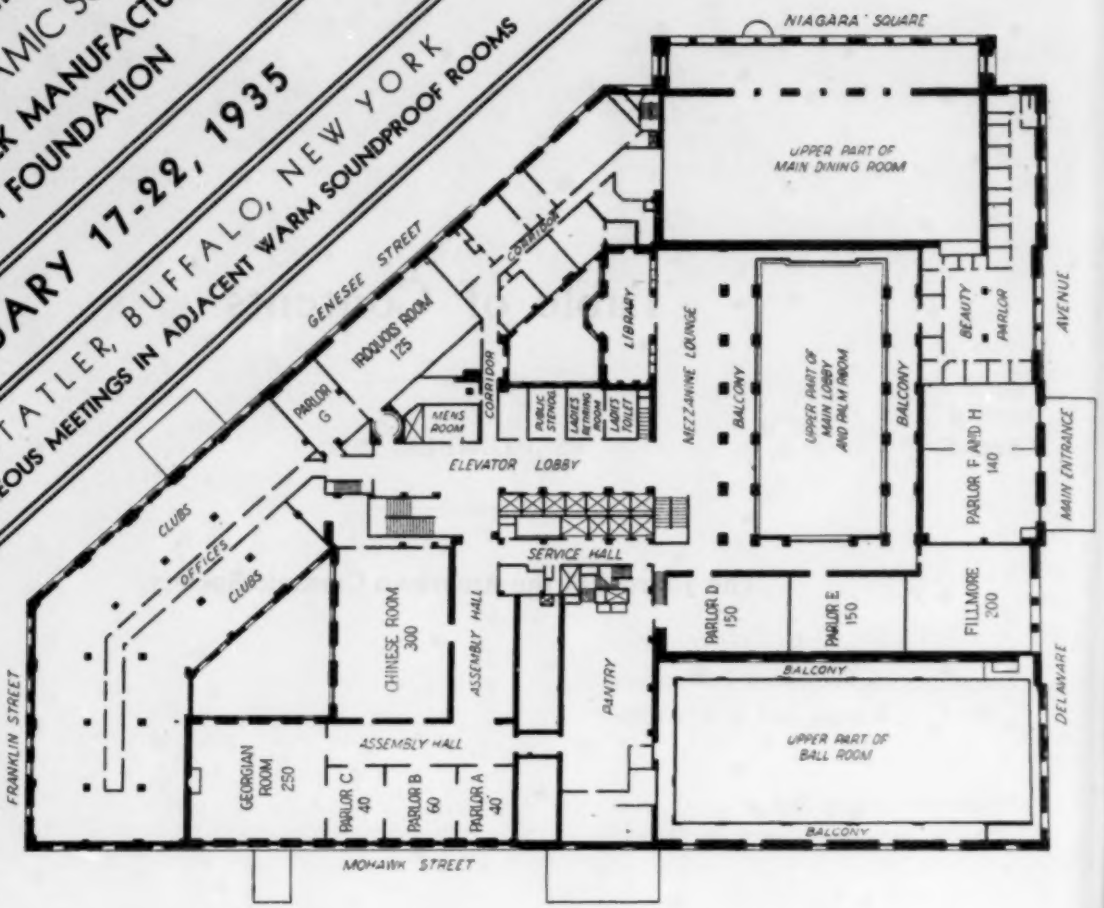
1935 ANNUAL MEETINGS

THE AMERICAN CERAMIC SOCIETY
THE NATIONAL BRICK MANUFACTURERS
RESEARCH FOUNDATION

FEBRUARY 17-22, 1935

HOTEL STATLER, BUFFALO, NEW YORK
EIGHT SIMULTANEOUS MEETINGS IN ADJACENT WARM SOUNDPROOF ROOMS



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THE DURABILITY OF TABLEWARE DECORATIONS*

By C. J. Koenig and A. S. Watts

ABSTRACT

(1) A survey is given of European research on overglaze decorated tableware tested with various solutions, which are indicated as simulating practical service. (2) A study has been made of some typical European and American tableware with overglaze decorations tested in commercial dishwashing solutions and also in various other solutions which may be encountered in service. Results indicate that acids are harmful on cobalt blues in practically all cases. Alkalis are harmful to practically all decorations, apparently through the destruction of the flux used in preparing the colors. Some commercial cleaning solutions are much more destructive than others.

I. Introduction

In the past few years numerous investigations have been conducted in Germany concerning the action of alkaline cleansing agents on overglaze decorated tableware. These investigations have also embodied the setting up of laboratory tests which are indicated as simulating practical service. A brief résumé of their conclusions is presented.

Kohl[1] found that a combination of testing methods is necessary to reproduce conditions in practice to determine the durability of porcelain colors in washing machines. He found that colors which withstand the five-hour action of a 3% HCl solution at room temperature and boiling with 1% solution of sodium carbonate for thirty minutes will be sufficiently acid-proof and alkali-proof in practice. He concluded that the present ceramic pigments are stable and that, out of 291 colors investigated, a large number of sensitive colors are used only in art and luxury porcelain. He recommends the washing agent, "Imi," which consists of 67% trisodium phosphate, 25% sodium carbonate, 5% sodium silicate, and 3% water.

Endell[2] treated six decorated porcelains with five 1/4% cleaning solutions, which are used in regular practice, at 40 to 50°C for fourteen hours, and the test pieces showed no decrease in gloss or change in color as the result of the treatment. However, only the products of two firms remained unchanged at the working temperature of 80 to 90°C. Solutions of 1/4% caustic soda at these temperatures completely destroyed all colors.

The Clay Industries Laboratory,[3] Berlin, found similar results as to the greatly increased corrosive attack at the higher temperatures.

Other earlier investigators used acid solutions for determining color durability. Tests of this nature, however, do not give a true indication of alkaline attack.

The purposes of this study were (1) to compare the durability of American overglaze colors with those of Germany and various other countries, and (2) to ascertain whether the conditions to which hotel china is subjected in American hotels and restaurants are injurious to the various overglaze colors.

II. American Practice

Acquaintance with the operation of the washing machine was acquired by the inspection of hotels and restaurants in Columbus and by questionnaires to representative hotels and restaurants in the United States. The ordinary cleaning agents, in addition to the many commercial preparations, are trisodium phosphate, sodium carbonate, neutral and alkaline soaps, and occasionally sodium metasilicate. The average concentration of these cleaning agents, based on twenty-five reports, is approximately 1/8%, although in extreme cases as high as 1 1/2% and as low as 1/16% were used. The temperatures in the cleaning chamber varied from 40 to 80°C, the average being 65°C. The temperatures in the rinsing chamber averaged 90°C, the maximum and minimum temperatures were 100°C and 70°C, respectively. The working period was about one minute in the cleaning chamber and from 1/2 to 1 minute in the rinsing chamber. In general, high concentration and high operating temperatures

* Presented at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934 (White Wares Division). Received February 15, 1934.

[1] (a) H. Kohl, "Cause of Fading of Decorations on Porcelain Ware during Cleaning," *Sprechsaal*, **64** [16], 295–96 (1931); *Ceram. Abs.*, **10** [8], 582 (1931).

(b) *Ibid.*, "Durability of Ordinary Porcelain Colors in Washing Machines and in the Laboratory," *Sprechsaal*, **64** [48], 887–90; [49], 907–908 (1931); *Ceram. Abs.*, **11** [3], 187 (1932).

[2] K. Endell, "Effect of Alkaline Cleansing Materials on Color-Decorated Hotel Dinnerware," *Ber. deut. keram. Ges.*, **12** [11], 548–55 (1931); *Ceram. Abs.*, **11** [5], 314 (1932).

[3] "Dekorierte Porzellan in Waschmaschinen: Gutachen des Laboratoriums für Tonindustrie, Berlin. Zusammenfassung abgedrucht," *Keram. Rund.*, **38**, 658 (1930).

went hand in hand, thus producing severe conditions.

These conditions may be contrasted with those prevalent in Germany where, according to Endell, the maximum temperature in the cleaning chamber is 60°C and the ordinary working concentration is approximately 1/4%. The working period and rinsing temperatures on the other hand are about the same as in this country. Several German investigators pointed out the fact that if the cleaning chamber temperature is raised above 60°C, egg white food residues on plates will invert to an insoluble form and are then very difficult to remove. It has been interesting to note that American operators, in all cases where temperatures higher than 60°C are employed, list eggs as the most difficult food to remove.

III. Test Methods

The laboratory tests were conducted in the following manner. Tableware, including three German, two French, one English, one Japanese, and three American specimens, were broken into pieces and sufficient portions of each were laid aside for the comparison of colors. One group of test pieces was heated at a temperature of 65 ± 2°C for three 5-hour periods or a total of fifteen hours, immersed in 1/3% solutions of washing agents. This heating was done in Pyrex-brand beakers, covered with watch glasses to prevent evaporation, and uniformity of temperature was maintained by using a water bath. Tests were conducted also with a 3% HCl solution for five hours at room temperature, with 4% acetic acid for twenty-four hours at room temperature, and some with boiling 1% Na_2CO_3 solution for 1/2 hour.

The appearances of the colors have been classified according to the following standard, (1) unaltered, (2) less glossy, (3) slight fading, (4) pronounced fading, and (5) completely destroyed.

IV. General Discussion of Results

The results of the tests are given in Table I.

The effects produced by a solution on the various colors of a given plate were averaged and this number in turn was averaged with the similar mean values of the other solutions. By this procedure a numerical basis of classification was afforded.

With the exception of one French ware, the decorations of which appeared to be improperly fired, the decorations on the vitreous ware have relatively near the same durability. The best resistance was shown by specimens of one of the American brands which, however, apparently had carefully selected colors. Both the English and the American semiporcelain ware were appreciably more sensitive than the vitreous ware.

The acid attack was more selective than that of the alkalis, the former in many cases completely destroying one color without harming the others. The dark, cobalt blues were notably sensitive to acid attack. In the case of acetic acid attack on cobalt blues, a red residue was left which was probably cobalt acetate. Blacks also were readily attacked, particularly by HCl.

The alkaline attack was more general in nature, as can be seen from the data in Table I. This is due to its attack on the glassy phase, which is to be expected as it is well known that glass is more soluble in alkaline than in acid solution. The general dull surfaces produced by the former are evidently due to the removal of the upper layers of the glassy phase. Another factor which points to the glassy phase as being dissolved is that in some cases the colors could be rubbed off although their intensity was practically unaltered.

Soaps with free alkali content which are occasionally encountered in practice, especially in cases where the restaurants make their own soap with lye base, have been found to be very "unfriendly" to colors at a temperature of 65°C. The operating temperature in the cleaning chamber is of great importance inasmuch as the rate of most chemical reactions is doubled with a rise in temperature of 10°C.

Test pieces were placed also in various juices of fruits and vegetables and in tap water for ten days at room temperature and also in boiling tap water for five hours, without any harmful results.

To correlate the tests of group I with service, it can be assumed that the average time of subjection of the dinnerware to the cleaning solution per washing is one minute and that the dishes are washed six times a day. The alkaline solutions were prepared in concentrations used in practice and the temperature maintained near that used commonly in most dishwashing operations. This practice would be equivalent to six minutes per day or fifteen hours per 150 days. Thus in this length of service there is a noticeable effect in the appearance of the decorations as a result of average operation.

TABLE I

I. 1/8% trisodium phosphate
II. 1/8% sodium carbonate
III. 1/8% commercial cleaner
IV. 4% acetic acid
V. 5% hydrochloric acid

Temp. (°C)	Time (hr.)
65 ± 2	15
65 ± 2	15
65 ± 2	15
22	24
22	5

		I	II	III	IV	V
	(A) German vitreous body					
1	Gold	1	1	1	1	1
2	Black	3	3	4	1	1
3	Grass green	2	3	3	1	1
4	Pale gray	1	2	3	1	1
5	Russet brown	3	3		1	1
6	Light brown	1	2		1	1
7	Pink	3	2	3	1	1
8	Pale blue	1	1+	2	2	3
9	Lavender-violet	2	3		1	
	Av.	1.9	2.2	2.8	1.1	1.2
	Av.			1.8		
	(C) English porous body					
1	Gold	1	1	1	1	1
2	Light brown	3	3	4	1	3
3	Buff-yellow	2	3	3	1	1
4	Light blue	2	3	3	1	1
5	Blue-green	3	3	4	1	4
6	Dark blue	3	3		5	
7	Rose-pink	1	2		1	
8	Dark red	2	4		1	
9	Empire yellow	3	3		4	
10	Leaf green	2	3		4	
11	Black	1	3		4	
	Av.	2	2.8	3	2.2	2
	Av.			2.4		
	(E) German vitreous body					
1	Fawn brown	3	2	3	1	1
2	Dark brown	3	2	3	1	1
3	Yellow	3	2	3	1	1
4	Deep rose pink	3	3	3	1	1
5	Light green	2	3	3	1	1
6	Drab	1	2	3	1	1
7	Gold	1	1	1	1	1
8	Violet	3	2	2	2	4
	Av.	2.3	2.1	2.6	1.1	1.4
	Av.			1.9		
	(G) American porous body					
1	Gold	1	1	1	1	1
2	Dark blue	4	3	3+	5	5
3	Black	3	3	3	3	4
4	Gray	1+	1	2	2	2
5	Yellow	2	2	3	2	2
6	Red	3	3	3	3	3
7	Green	3	3	3	3+	3
	Av.	2.4	2.3	2.6	2.7	2.8
	Av.			2.5		
	(I) French vitreous body					
1	Gold	1	1	1	1	1
2	Dark blue	1	1	1	4	4
3	Leaf green	1	1	3	1	1
4	Apricot yellow	2	2	4	1	1
5	Red	2	2	3	2	2
6	Cinnamon drab	2	2	3	1	1
	Av.	1.5	1.5	2.5	1.7	1.7
	Av.			1.7		

		I	II	III	IV	V
	(B) German vitreous body					
1	Gold	1	1	1	1	1
2	Oriental green	2	2	3	1	1
3	Leaf green	1	3	3	1	1
4	Black	2	3	3	2	4
5	Deep rose pink	3	3	4	4	
6	Red	3		3		
7	Blue	2	2	3	5	
8	Cinnamon	1	1	2	1	1
9	Amber-yellow	1	1		1	1
	Av.	1.6	2	2.7	1.9	1.5
	Av.			1.9		
	(D) Japanese vitreous body					
1	Gold	1	1	1	1	1
2	Baby blue	1	2	3	1	1
3	Black	1+	3	3+	1	1
4	Forest green	1	3		1	
5	Citron yellow	1	2	2		1
6	Dark blue	1	1		4	4
7	Orange	1	1		1	
8	Light green	1	1			
9	Dahlia carmine	3	3		1	
10	Violet	1			1	
11	Ivory	3	2	3	1	1
	Av.	1.2	1.7	2.2	1.5	1.5
	Av.			1.6		
	(F) French vitreous body					
1	Apricot yellow	3	3	3	1	3
2	Baby blue	2	2	3	1	3
3	Light leaf green	2	2	4	1	3
4	Dull red	2	3	3	1	3
5	Dull dark green	3	3	3	1	4
6	Light ivory	5	5	5	5	5
	Av.	2.9	3.0	3.5	1.6	3.5
	Av.			2.8		
	(H) American vitreous body					
1	Gold	1	1	1	1	1
2	Grass green	2	1	3	1	1
3	Amber yellow	1			1	
4	Violet	1	1	2	1	1
5	Deep rose pink	1	1	1	1	1
6	Brown	2	1	3	1	1
	Av.	1.3	1	2	1	1
	Av.			1.4		
	(J) American vitreous body					
1	Gold	1	1	1	1	1
2	Black	2	1	3	1	1
3	Dahlia carmine	3	2	3	1	1
4	Dark blue	2	1	3		3
5	Light blue	1	1	3	1	
6	Blue		1		1	1
7	Leaf green	0	2	3	1	1
8	Orange-yellow		3	3	3	
9	Yellow	2	2	3	1	1
10	Deep lavender	2				1
11	Orange-red	2	2	3	1	1
12	Rose	2	2	2	1	1
	Av.	2	1.7	2.8	1.2	1.1
	Av.			1.8		

Various commercial cleaners were studied to determine their relative corrosive action. There are two fundamentally different types of cleaners, (1) those which saponify or combine chemically with grease and (2) those which emulsify or break up dirt and grease into tiny particles, placing them in a state of suspension which facilitates easy rinsing. The latter, a comparatively new type of cleaner, has been found, after much experimentation by one restaurant operator, to have the least effect on colors and also good cleansing ability. Experiments conducted here have also shown this type to be more "friendly" to the colors.

V. Conclusions

(1) The colors on specimens of three German, two French, one Japanese, and two American vitreous tableware (with the exception of one of French manufacture, the decorations of which appeared to be improperly fired) had relatively the same durability. The best resistance was shown by one sample of American tableware which apparently had carefully selected colors. The colors on both the English and American semiporcelain ware were appreciably more sensitive than those on the vitreous ware.

(2) As a result of the present average American operating conditions, there is a noticeable effect on the appearance of the decorations after 150 days of service. This corrosive attack may be greatly reduced by limiting the maximum temperature in the cleaning chamber to 60°C and by using those cleaning agents which depend chiefly on emulsification of the dirt and grease. Under such conditions, corrosive attack is undoubtedly secondary to mechanical abrasion.

Additional References

1. R. Rieke and L. Mauve, "Acid Resistance of On-Glaze Colors," *Ber. deut. keram. Ges.*, **11** [9], 487 (1930); *Ceram. Abs.*, **10** [5], 365 (1931).
2. W. Funk and M. Mields, "Resistance of Colored Enamels to Dilute Acids and a Process for the Determination of Their Lead Solubility," *Ber. deut. keram. Ges.*, **12** [11], 535–48 (1931); *Ceram. Abs.*, **11** [5], 315 (1932).
3. R. B. Tailby, "Acid-Resisting Overglaze Colors," *Jour. Amer. Ceram. Soc.*, **11** [5], 307 (1928).
4. H. Eisenlohr, "Acid-Resistant Colors: Testing," *Sprechsaal*, **59** [39], 645 (1926); *Ceram. Abs.*, **7** [2], 70 (1928).
5. E. Killias, "Influence of Alkaline Cleaners on the Resistance of Underglaze Colors," *Ber. deut. keram. Ges.*, **11** [11], 602–606 (1931); *Ceram. Abs.*, **10** [5], 365 (1931).
6. R. Rieke, Reply to E. Killias, *Ber. deut. keram. Ges.*, **11** [11], 607 (1931); *Ceram. Abs.*, **10** [5], 366 (1931).

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NOTES ON CASTING SLIP*

By Edward Schramm and F. P. Hall

ABSTRACT

Casting behavior depends on the properties of the mold, the slip, and the casting formed. The water retention of the casting is of especial significance, and experiments reveal how this depends on the nature and condition of the slip. Tannic and gallic acids as deflocculents are more effective when used in the form of sodium salts. These organic agents serve as protective colloids to reduce attack on molds.

I. Introduction

The casting process and the control of casting slips are of universal interest in whiteware manufacture. For a bibliography the reader is referred to papers by Mautz[1] and by Hall.[2]

The usual control of casting slip is through specific gravity and viscosity measurements. These two properties are inadequate to describe a slip completely, and recourse is had to working trials to determine "casting behavior." Casting behavior is largely a question of selection of materials, and the required properties must vary according to the nature of the work.

In this complex situation a clearer understanding of the various factors may be obtained by an analysis of the process requirements. In the first place, the operation presupposes a certain fluidity of slip. From this fluid slip it is necessary to build up a clay layer at the greatest possible rate, which layer must be sufficiently firm and rigid to hold its shape and permit trimming but must not be overhard and crumbly. The casting must not pull away from the mold too soon nor must it stick too tight.

These requirements limit the permissible water retention of the built-up layer. The operation is analogous to filter-pressing. Since the problem

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[1] Paul H. Mautz, "The Function of Peptizing Protective Colloid in the Casting of Clay Slips," *O. S. U. Eng. Expt. Sta. Bull.*, No. 55 (1930).

[2] F. P. Hall, "Casting of Clay Ware," *Jour. Amer. Ceram. Soc.*, **13** [10], 751 (1930).

is one of water removal it is necessary to produce slip of high specific gravity and one which forms a casting permitting free passage of water. To these major conditions may be added the requirements of uniformity of casting and, in the case of hollow or pour-off casting, of good drainage. The use of dispersing agents is necessary to meet these specifications for the slip. Finally the mold must be considered as to hardness, uniformity of absorption, and resistance to disintegration. The various casting factors are listed below:

Properties of Cast

(*a*) Good rate of water transfer
(*b*) Correct water retention
(*c*) Rigidity or set
(*d*) Plasticity
(*e*) Smoothness
(*f*) Uniformity
(*g*) Release from mold

Properties of Slip

(*a*) Low water content
(*b*) High fluidity (dispersion)
(*c*) Homogeneity
(*d*) No rapid settling out

Properties of Molds

(*a*) High rate of water absorption
(*b*) Uniformity
(*c*) Hardness
(*d*) Resistance to disintegration

Many of the listed properties tend to be mutually incompatible, and the art of casting consists in reaching a state of happy compromise. It will be noted that the rate of casting, often referred to as the prime factor, is not listed in the present scheme, for it is the resultant of a number of the properties given. No attempt is to be made to expand discussion of all these items, but these notes will be confined to reports of experiments and observations on three subjects, (1) water transfer and retention, (2) dispersing agents, and (3) mold attack.

II. Water Transfer and Retention

There is little information concerning the movement of water in the casting operation. In drying plastic clay, however, many data are available and reference may be made to recent papers by Mellor[3] and by Norton and Hodgdon.[4] Of the facts developed, the most significant in casting is the low rate of water passage through very fine clay caused by a clogging of the capillaries. As between different materials, therefore, the coarser favor rapid water movement.

III. Flocculated State Aids Water Movement

For any given clay, water passage is more rapid in a flocculated or partly flocculated state than in the dispersed state. However, it is impossible to go very far in utilizing this phenomenon in casting, since the requirement of high specific gravity and fluidity compels us to work in the deflocculated range and because casts made from flocculent slip possess too high water retention with an attendant absence of rigidity. Nevertheless, it is possible to proceed too far with dispersion or to produce dispersion with reagents which cause unfavorable phenomena, slowing down the casting rate, settling out in the molds, "livering" or localized coagulation of the slip on standing, or uneven casting. The purpose here is to point out the interest which should attend a systematic study of water movement in casting and to indicate the possibility of an experimental attack on the problem.

(1) Test of Water Movement

One method of approach consists of casting test pieces under standardized conditions and of determining the weight of casting and the water content of the casting, thus affording information on "build up" and water retention. Experiments along this line were carried out with two vitreous china bodies and a high-tension electrical porcelain body.

Viscosity is recorded as time of flow of 250 cubic centimeters of slip from a standard viscosimeter. The test cast was a small hotel ware cream jug; the casting time in all cases was 15 minutes, and the draining time after the pour-off was 7 minutes. These data are assembled in Table I which presents data for three distinct sets of trials intended to cover the range of slip conditions. With each of the three bodies there is a series starting with a slip of high specific gravity and high viscosity con-

NOTE: The electrical porcelain body, Table I, contains three times as much ball clay as the vitreous bodies; the vitreous bodies contain equal quantities of ball clay, but the clay used in body A carries twice as much lignite as that in B. The three bodies form a series of decreasing organic colloid content and increasing average grain size. The weight of casting (casting rate) and water content of the casting under comparable conditions increase with the grain size.

[3] J. W. Mellor, "Shrinkage of Clays during Drying," *Trans. Ceram. Soc.* [Eng.], **32**, 455 (1933).

[4] F. H. Norton and F. P. Hodgdon, "Notes on the Nature of Clay, Part I," *Jour. Amer. Ceram. Soc.*, **15** [3], 191 (1932); F. H. Norton, Part II, *ibid.*, **16** [2], 86 (1933).

TABLE I

Body	No.	Sp. gr. of slip	Viscosity of slip	Weight of cast (gram)		Water in cast (%)	Water in slip equivalent to dry weight of casting (gram)	Water absorbed by mold (gram)
				Wet	Dry			
Electrical porcelain	1	1.921	310	88.5	74.9	15.4	22.2	8.6
	2	1.888	104	75.8	64.5	14.9	20.9	9.6
	3	1.860	61	68.1	58.1	14.7	20.2	10.2
	4	1.809	34	58.5	50.0	14.5	19.6	11.1
Vitreous A	5	1.843	255	106.2	86.1	18.9	31.2	11.1
	6	1.818	100	98.3	80.2	18.4	30.9	12.8
	7	1.787	56	93.2	76.2	18.2	31.4	14.4
	8	1.743	33	82.5	67.8	17.8	31.2	16.5
Vitreous B	9	1.824	130	115.4	93.5	19.0	35.7	13.8
	10	1.808	90	110.5	89.7	18.8	35.4	14.6
	11	1.788	52	106.5	86.6	18.7	35.8	15.9
	12	1.750	34	95.0	77.5	18.4	35.4	17.9
Vitreous B	13	1.770	275	Cast solid		Very soft		
	14	1.770	78	134.6	106.6	20.8	45.8	17.8
	15	1.770	50	114.6	93.3	18.6	40.1	18.8
	16	1.770	46	103.4	84.2	18.6	36.2	17.0
Vitreous B	17	1.810	128	102.5	83.7	18.4	32.8	13.9
	18	1.779	59	93.5	76.3	18.4	32.2	15.0
	19	1.740	40	94.6	76.5	19.1	35.4	17.3
	20	1.776	59	93.0	76.1	18.2	32.4	15.4

NOTE: Weighings of the wet and dry casting together with the specific gravity of the slip supply data for the calculated results in the last three columns, per cent water in casting, water in the slip equivalent to the dry weight of casting obtained, and water absorbed by the mold, which is the difference between the equivalent water and the water in the casting. The last calculation involves the assumption that there is no impoverishment in water of the excess slip which is poured off, an assumption justified by common experience in casting and checked in the following manner: very heavy castings were made with the electrical porcelain and vitreous bodies used in this work, so that approximately half the slip was consumed in the operation; careful determinations of specific gravity of slip before and after the cast showed no significant increase.

taining the normal quantity of deflocculent (Nos. 1, 5, and 9).

(2) Decreasing Specific Gravity and Viscosity By addition of water, slips were prepared of decreasing specific gravity and viscosity (Nos. 1 to 4, 5 to 8, 9 to 12). The effect of such dilution is to increase the dispersion of the clay, since the amount of reagent suitable for the heavy slip is excessive for the lighter slips. This is a condition, however, commonly encountered in practice whenever a slip which is too sluggish is brought into condition by adding water.

(3) Constant Specific Gravity—Decreasing Viscosity With vitreous body B two further series were prepared. Numbers 13 to 16 represent constant specific gravity and decreasing viscosity, Nos. 13 and 14 being inadequately dispersed, No. 15 in a normal condition, and No. 16 containing twice the normal quantity of reagent.

(4) Decreasing Specific Gravity and Viscosity The final series (Nos. 17 to 19) covers decreasing specific gravity and viscosity, but in this case the slips were made up separately in such fashion that the quantity of reagent was adjusted to bring the three slips to corresponding points on the viscosity curve, the amount being a little short of that required for minimum viscosity at the particular specific gravity.

The last slip, No. 20, was prepared by dilution of No. 17 and represents a check-back on the first series (Nos. 1 to 12).

IV. Discussion

(1) Decreasing Specific Gravity Considering the first series, Nos. 1 to 12, for all three bodies, the casting rate and per cent water in the cast decrease with decreasing specific gravity of the slip. For the vitreous china bodies there is a practical con-

stancy in the figures for water in the slip equivalent to the casting formed. This may be taken as indicating that in the early stage of casting the result is determined by the capillary attraction of the mold for water, since a definite quantity of water is removed from the slip. The distribution of this water between mold and cast is determined by the physical condition of the casting. With the electrical porcelain body high in ball clay there is a consistent falling off in "equivalent" water with specific gravity of slip. With this type of body, even in a 15-minute cast, the slow water passage is an important factor. There is also a greater falling off in casting rate as the specific gravity of the slip is reduced.

(2) Constant Specific Gravity Considering now the constant specific gravity series, Nos. 13 to 16, striking changes are noted from the first member, No. 13, which gelled in the mold to a soft mass with little water removed, through No. 14 which formed a cast with high water content, to No. 15, properly dispersed, which gave a water content consistent with the first series (Nos. 9 to 12). The excess reagent added in No. 16 did not further affect the water retention of the cast but did cause a reduction of the casting rate and a tendency of the cast to stick in the mold. The values for equivalent water, instead of remaining constant, show a continual falling off with increasing dispersion of the slip; this is analogous to the fact that different bodies give different water-equivalent values, depending on the state of dispersion and grain size.

(3) Effect of Flocculation The last series, Nos. 17 to 20, represents in effect an attempt to compensate the opposing tendencies of dilution and flocculation as noted in the first two series. Numbers 17 and 18 gave identical values for water in cast and equivalent water. The relation of Nos. 20 and 17 is similar to that of Nos. 11 and 9 in series 1. In the case of No. 19 there is an actual increase in water retention of the cast from the low gravity slip, an apparent reversal of the tendency of the first series. It will be recalled that the criterion taken for similar slip condition was the correspondence of points in viscosity curves. Due to the naturally low range of viscosity values at very low specific gravity it is evident that this criterion failed and that No. 19 was relatively more flocculent than the other members of the series; hence the increased water retention of the cast.

The entire series of observations can be interpreted simply in terms of the packing of particles. Thus, with the clay content of fine grain, closer packing of bodies is obtained, giving drier castings, lower equivalent water values, lower rate of water transfer, and lower casting rate at a given specific gravity. With any given body, dispersion or dilution give closer packing (exactly as in sedimentation experiments) while flocculation or increased specific gravity yield a less dense cast of higher water content, with other properties falling naturally in place. In fact, the water content of a casting would appear to offer a dependable means of evaluating the condition of the slip from which it was formed.

The physical properties of the castings vary in a consistent manner with the specific gravity and viscosity of the slip. If these values are too high, the castings are over-soft, the pour-off is not sharp, the castings do not dry in the molds, and there is a tendency to form "wreathes." With lowered viscosity there is increasing hardness of cast and sharp pour-off (drainage) until, at the extreme, the cast is hard and brittle, difficult to trim, and subject to cracking.

(4) Shrinkage from Mold The shrinkage from the mold to the dry state is also determined by the density of packing and water retention. The following observations were made on solid cast bars 11 inches long, the thinner slips being made from the original heavy slips by dilution:

	Electrical porcelain body		Vitreous body B	
Specific gravity of slip	1.922	1.815	1.819	1.761
Drying shrinkage (%)	2.26	1.67	2.54	2.26
Water in cast (%)	15.4	14.5	18.9	18.5

Similar tests made on Nos. 17 to 20 in Table I gave the following results:

	17	18	19	20
Specific gravity of slip	1.810	1.779	1.740	1.776
Drying shrinkage (%)	2.40	2.40	2.96	2.40
Water in cast (%)	18.4	18.4	19.1	18.2

The shrinkage is fixed not by water content of slip *per se* or by viscosity but by water retention of the cast, the latter being controlled by conditions which have already been discussed. The tendency to cracking observed with over-thin slips is therefore not due to greater shrinkage, as sometimes stated, but primarily to the short or brittle condition of the cast obtained from such

slips. Some plasticity must be preserved in the casting. In practice it is found that for solid casting of thick sections best results are obtained with very heavy slips, and a high degree of fluidity is not essential; for hollow casting, on the other hand, fluidity is the determining factor.

(5) Effect of Temperature Many of the phenomena observed in casting can be interpreted in terms of the state of dispersion of the clay. The three chief factors affecting dispersion are (1) the temperature of the slip, (2) the ratio of water to clay (specific gravity), and (3) the p_H of the medium, which is controlled through the addition of alkali salts. The effect of temperature may be illustrated by an experience with a slip which at 15°C gave a time of flow of 154 seconds, but at 23° a time of 122 seconds, a difference which appears disproportionate to the purely thermal effect on viscosity of normal liquids and implies a change in state of aggregation. Dispersion by dilution is a matter of common observation and, indeed, a range of properties may be obtained by dilution which parallel to a large extent the range obtained by adding salts to a slip of definite specific gravity. However, it remains true that the third factor, the control of dispersion by salts, is of greatest practical importance and will be gone into further after a brief discussion of the rate at which these various changes occur.

(6) Effect of Aging The importance of aging is well known. Some slips, especially those high in sodium silicate, set up or gel on standing and may become "stringy" due to localized coagulation. Certain organic substances, notably tannic and gallic acids, act as protective colloids to prevent this gellation. Other slips, on the contrary, become progressively more fluid over a certain period of time, implying a failure to reach an equilibrium due to the sluggishness of change under the conditions of preparation. Two examples will be given, the first referring to the slowness of recovery from the effect of low temperature.

A certain slip which had been chilled gave a time of flow of 240 seconds when warmed to 21°C, but on heating to 45° and then cooling to 21°, the time had fallen to 135 seconds. The second example concerns the preparation of slip on a large scale. It is well known that it is more difficult to prepare slips directly from raw materials than from clay which has been through the usual process of blunging and filter-pressing. It has been the practice of the writers to use press cakes for the preparation of slip. A certain slip made in this fashion proved too viscous, having a specific gravity of 1.825 and flow time of 250 seconds. With no other change than the use of pugged clay instead of press cakes, there was obtained for the same specific gravity a flow time of only 130 seconds. This striking change may be attributed to the thorough distribution of water and wetting of all the clay particles in the pugging operation, thereby accelerating the disintegrating action of the water and salts added to make slip.

V. Effect of Dispersing Agent

(1) Tannic Acid The effect of the most common deflocculents, sodium carbonate and sodium silicate, has been amply covered in the literature. In practice they are usually used together in about equal amounts. More recently, tannic acid has come into prominence, and it appeared to offer especial advantage for use with relatively nonplastic bodies of low ball clay content. In the first experiments, a water solution of tannic acid was added directly to regular slips containing carbonate and silicate. In working with the tannic acid it became desirable to study its relative efficiency as compared to carbonate and silicate. In the first place it became apparent that the effectiveness of tannic acid depended very much on the manner in which it was prepared and incorporated in the slip. If added in aqueous solution it offered the advantages of a protective colloid but was not comparable to "water glass" (sodium silicate) as a dispersing agent. However, by dissolving the tannic acid in strong, hot sodium carbonate solution, forming sodium tannates and gallates, its efficiency was sharply increased. This is illustrated by the following data on slips, identical except for the manner of incorporating tannic acid.

Sodium tannate		Aqueous tannic acid	
Specific gravity	Time of flow	Specific gravity	Time of flow
1.760	46 seconds	1.764	90 seconds
1.784	92 seconds	1.786	121 seconds

(2) Comparison of Dispersing Agents To compare the effect of carbonate, silicate, and tannate, a highly viscous slip of specific gravity 1.780 was prepared by using the requisite water and an inadequate

amount of sal soda (1 gram per kilogram of plastic clay). A concentrated sal-soda solution was prepared containing 58 grams of salt per 100 cubic centimeters of solution. A sodium tannate solution was made by dissolving 30 grams tannic acid in 100 cubic centimeters of the above strong, hot sal-soda solution. A sodium silicate solution was made by adding 40 cubic centimeters of N brand silicate to 100 cubic centimeters of the sal-soda solution. These reagents were added in small successive portions to 1200 cubic centimeters of the viscous slip, blunging 15 minutes and determining viscosity after each addition. The results are recorded in Table II.

From the above results it appeared that sodium tannate was even more effective than silicate and

TABLE II

Sodium carbonate		Sodium tannate		Sodium silicate	
Cc. added (total)	Time of flow (sec.)	Cc. added (total)	Time of flow (sec.)	Cc. added (total)	Time of flow (sec.)
2	300	2	51	4	46
4	135	4	45	5	47
5	118	6	43	7	48
7	101	8	41	9	51
9	101	11	41		

that large amounts might be added without reversal of effect. It became possible to dispense with the use of "water glass" in making slip.[5]

Further experiments indicated that sodium gallate is still more active than tannate. Gallic acid reacts violently with the soda solution but is less soluble than tannic acid, so that the concentration must be limited to 12.5 grams of gallic acid to 100 cubic centimeters of the strong soda solution described above. This solution proved fully as good as the tannate, although it contained only 40% as much organic acid.

VI. Mold Attack

(1) p_H of Slip Lowered by Tannic Acid

One of the important items of cost in casting is replacement of molds which have become pitted through the action of salts. Accordingly, an effort was made to determine by accelerated tests the comparative harmfulness of various deflocculents. As the alkalinity of the slip appeared to be an important factor, the first step was the determination of p_H value. Three slips were prepared of identical specific gravity, all containing the quantity of reagent needed to give slips of the same viscosity. The slips were filter-pressed and the p_H determined colorimetrically. The results follow:

Deflocculating agent	p_H of slip
Sodium aluminate	9.2
Sodium carbonate and sodium silicate	8.6
Sodium carbonate, sodium silicate, and tannic acid	8.0

It is interesting to note that with the addition of tannic acid equal fluidity is obtained with a less alkaline condition.

(2) Effect on Molds of Dispersing Agents

For more direct evidence, a series of tests was carried out in which plaster plugs were immersed for four half-hour periods in aqueous solutions of various reagents, similar in salt concentration to casting slip. This test is admittedly more severe than practice, since the clay exerts a protective effect. However, the results were very striking and are listed below in the order of decreasing attack on the plaster.

Sodium hydroxide Sodium carbonate Sodium carbonate and sodium silicate	Very bad
Tap water Sodium aluminate	Bad
Sodium silicate Sodium aluminate and tannic acid Sodium carbonate and tannic acid Sodium carbonate, sodium silicate, and tannic acid	Attack negligible

Tannic acid serves to protect the molds against the disintegrating action of alkali salts. One contributing factor was noted above in the lowered p_H, but there is also undoubtedly a direct effect due to absorption of protective colloid by the mold. "Water glass" alone produces very little attack, but does not protect against attack by other salts as does tannic acid.

NOTE: Since the above notes were written, there has appeared a valuable paper on casting slip which the authors wish to commend to the reader: H. W. Webb, "Alkaline Casting Slip," *Trans. Ceram. Soc.* [Eng.], **33** [4], 129–67 (1934).

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[5] In practice it was found advisable to add a small quantity of preservative such as formaldehyde or sodium benzoate to tannate slips to protect them against changes due to bacterial action.

NOTES ON SOME EFFECTS OF THE VARIETY OF FLINT USED ON THE PROPERTIES OF A HOTEL CHINA BODY*

By C. L. Thompson

ABSTRACT

Pebble, sand, rock, and tripoli flint were used in a hotel china composition. The variety of flint was found to have little effect on the water absorption of the body fired to cone 10, on its linear thermal expansion to 300°C, or on its impact strength. The pebble-flint body crazed most easily in a water-dip test, while the sand-flint body was most resistant to crazing. The body containing rock flint was superior in translucency, the sand flint next, the tripoli flint third, while the pebble-flint body was practically opaque.

I. Introduction

(1) Purpose This investigation was undertaken to determine what effects were produced on the properties of a hotel china body by the variety of flint used in the composition.

II. The Flints Used

(1) The Flints Used Four varieties of flint were used,[1] (1) pebble or true flint, prepared by calcining and grinding flint pebbles from the coast of France and Belgium, (2) eastern sand flint, made by grinding a quartz sandstone, (3) rock flint, made by grinding rock quartz from a pegmatite dike, and (4) tripoli flint, made by grinding a soft, cryptocrystalline quartz rock occurring in southern Illinois.

The chemical compositions and specific gravities of the flints are given in Table I. The compositions show little difference in the samples. The specific gravity of the pebble flint indicates partial inversion to cristobalite during calcination.

TABLE I

CHEMICAL ANALYSES* (IGNITED BASIS) AND TRUE SPECIFIC GRAVITIES OF THE FLINTS

	Pebble flint (%)	Sand flint (%)	Rock flint (%)	Tripoli flint (%)
SiO_2	99.38	99.77	99.28	99.81
CaO	0.58	0.23	0.43	0.21
Total	99.96	100.00	99.71	100.02
True specific gravity	2.548	2.647	2.652	2.645

* J. M. Lindgren, analyst.

The particle-size distribution curves for the samples of flint are shown in Fig. 1. These curves were obtained by timing the rate of settle of the particles of flint in a column of water 90 centimeters high. Calculations of diameters were made by Stokes' law. While the curves probably do not represent the true particle-size distribution of the flints, they are valid for comparison of the relative fineness of the samples as all determinations were made under identical conditions and the shapes of the particles are similar in all but the tripoli. The pebble, sand, and rock flints are of practically the same degree of fineness, but the tripoli flint is appreciably finer.

(2) The Bodies Made A typical hotel china composition[2] was selected for the study as follows:

Dorset English ball clay	7.5%	Buckingham feldspar	18.0%
Florida kaolin (EPK)	8.0	Whiting	1.5
		Flint	36.0
English china clay (A1)	29.0		

Four bodies were made, differing only in the kind of flint used, and were prepared by grinding for five hours in a ball mill. Microscopic examination of the raw bodies shows that the grinding affected the size of the pebble, sand, and rock flint to the same degree, but made the tripoli even finer grained in comparison with the others than it had been before. The slip was screened through a 140-mesh sieve into a cloth-lined plaster vat, dewatered, and allowed to air-dry. The air-dried bodies were shipped to a commercial plant where they were made into six-inch, rolled-edge plates and biscuited at cone $10^1/_2$. The plates were then decorated and glazed. In all firings the plates were in the same position in the same kiln, so the heat treatment was uniform.

III. Tests Made

(1) Water Absorption The absorption was determined with fragments broken from the center of the plates.

(2) Impact Strength The impact strength was determined on three plates of each composition with an instrument of the swinging-pendulum type.

* Presented at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934 (White Wares Division). Received February 15, 1934.

[1] E. E. Pressler and W. L. Shearer, "Properties of Potters Flints and Their Effects in Whiteware Bodies" *Bur. Stand. Tech. Paper*, No. 310 (1926).

[2] R. F. Geller, "Investigation of Feldspar," *Jour. Amer. Ceram. Soc.*, **10** [6], 423 (1927).

(3) Resistance to Crazing The resistance to crazing was determined by the water-dip test. Samples were heated in an oven at 150°C and quenched in running water having a temperature of 18°C. The cycles of heating and cooling were continued until crazing occurred or the test was discontinued. Tests were made also by quenching plates heated to 175°C and 190°C. Fragments of plates from the impact tests were used for the latter temperature and as checks on the 175°C tests. In all others, whole plates were used.

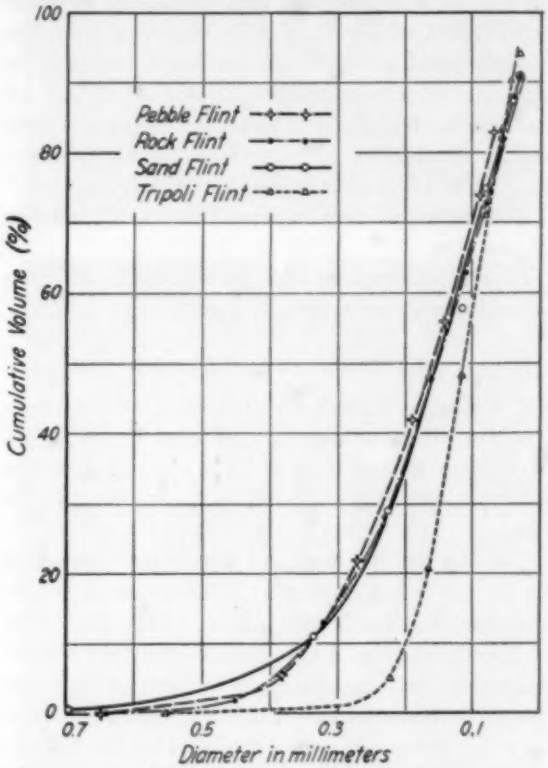

FIG. 1.—Particle size of flints; sedimentation curves.

For delayed crazing, one plate of each body was subjected to an autoclave test for one hour at 150 pounds steam pressure.

(4) Translucency The relative translucency of the plates was determined with a Weston photoelectric illuminometer.

(5) Linear Thermal Expansion The thermal expansion of each of the bodies was determined by the Fitzeau-Pulfrich interferometer method.

(6) Microscopic Examination Thin sections cut from the plates were examined to determine the amount of the quartz solution, nature of the residual flint, nature of the glaze contact, and thickness of the glaze coating.

IV. Test Results

(1) Absorption All of the bodies had zero water absorption.

(2) Impact Strength The number of specimens available for the impact-strength tests was not sufficient for satisfactory results. The test values indicate little difference in the bodies, with perhaps a little superiority in the plates containing pebble flint. The results are given in full in Table II.

TABLE II

IMPACT TEST RESULTS

Body No. 1 Sample	(a)	Pebble flint (b)	(c)	Average
Foot-pounds	0.350	0.250	0.300	0.300
Thickness (cm.)	0.552	0.549	0.542	
Body No. 2		Sand flint		
Foot-pounds	0.250	0.275	0.275	0.250
Thickness (cm.)	0.535	0.535	0.535	
Body No. 3		Rock flint		
Foot-pounds	0.250	0.250	0.250	0.250
Thickness (cm.)	0.534	0.541	0.531	
Body No. 4		Tripoli flint		
Foot-pounds	(defective)	0.300	0.250	0.275
Thickness (cm.)		0.528	0.527	

(3) Crazing Tests In the water-dip tests the plates containing pebble flint were first to craze, while those with rock flint were slightly more resistant. The plates containing tripoli flint were a little inferior to the sand-flint body, which was most resistant to crazing. Both of the latter bodies were uncrazed after twelve dips from 175°C. The results are tabulated in Table III.

None of the plates crazed in the autoclave test.

TABLE III

WATER-DIP CRAZING TESTS

Body No.	Flint used	Temperature 150°C	175°C	190°C
1	Pebble	All O. K. after 10 dips	Crazed 5th dip	Crazed 1st dip
2	Sand		O. K. after 12	Slight craze 4th dip
3	Rock		Crazed 6th dip	Crazed 3rd dip
4	Tripoli		O. K. after 12	Crazed 4th dip

(4) Translucency The translucency of the bodies varied greatly. The body containing rock flint was most translucent while that containing pebble flint was practically

opaque. The relative translucency, rating the most translucent as ten, is as follows:

Body	Flint	Translucency
1	Pebble	3
2	Sand	6
3	Rock	10
4	Tripoli	5

(5) Linear Thermal Expansion The thermal expansion of the different bodies was practically the same up to 300°C. Above this temperature, the quartz discontinuity begins to be apparent. The following order for the flints shows their relative effect on increasing the amount of thermal expansions of the respective bodies due to quartz inversion:

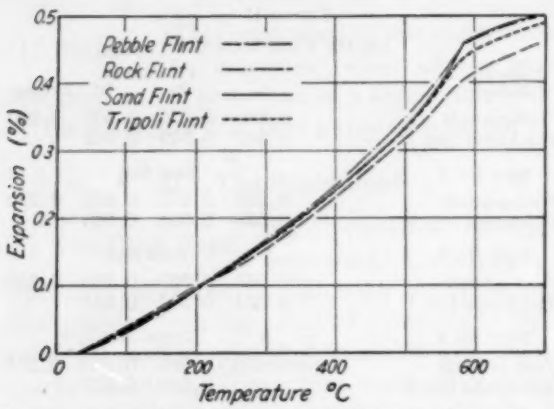

FIG. 2.—Thermal expansion curves of hotel china bodies.

pebble flint, tripoli flint, rock flint, and sand flint. The expansion curves are shown in Fig. 2.

(6) Microscopic Examination

(a) Pebble-Flint Body Many of the flint grains were practically opaque due to cristobalite; other grains showed the typical cryptocrystalline structure of true flint. Only the smaller flint grains showed any signs of solution. The glaze contact was uneven, with small needles projecting a short distance into the glaze, a few bubbles, and an occasional flint particle projecting a considerable distance into the glaze. Any microdetermination of the amount of flint remaining in the body was very difficult because of the cryptocrystalline nature of the particles and lack of relief.

(b) Sand-Flint Body The quartz grains showed clear and transparent. Most of the small grains were appreciably rounded due to solution, and many of the larger grains had solution rims. A microdetermination of the residual quartz gave 24.9%. The glaze contact is uneven and differs from that of the preceding body only in that no bubbles were present at the contact.

(c) Rock-Flint Body There is no apparent difference in the microstructure of this body and the one containing sand flint. A determination of the residual quartz gives an almost identical value, 25.0%.

(d) Tripoli-Flint Body Because of the fine-grained and cryptocrystalline nature of the tripoli flint, the body was of extremely fine texture. It was practically impossible to distinguish the flint grains from the background, which was partly due to the fact that even the small grains of the flint are made up of an aggregate of several minute quartz crystals. An estimation of the amount of solution of the flint was impracticable. The glaze contact was somewhat more even than in the other samples.

The glaze thickness was practically the same in all samples.

Photomicrographs of the bodies, taken between crossed-nicols, are shown in Fig. 3.

V. Discussion of Results

The results of the tests show that some properties of a vitreous body are affected but little by the variety of flint used in the composition, while other properties are altered to a considerable extent.

The reason for some of these differences in properties is not apparent. The thermal expansion curves of the bodies, nature of the glaze contact, or thickness of the glaze coating do not explain the lower resistance to crazing of both the pebble-flint and rock-flint bodies. It was thought that the lower thermal expansion of the pebble-flint body, the bubbles at the glaze contact, and local stresses due to the cristobalite in the larger flint grains might contribute to the crazing of the glaze on this body. These conditions were all absent in the body containing rock flint, yet it showed but slightly greater resistance to crazing. The glaze thickness was practically the same on all plates.

The inferiority of the pebble-flint body in translucency is caused by the opacity of the flint particles, due to their cryptocrystalline nature and inversion to cristobalite. The lower translucency of the tripoli-flint body is caused by its fine particle size and cryptocrystalline nature. The reason for the great superiority in translucency of the

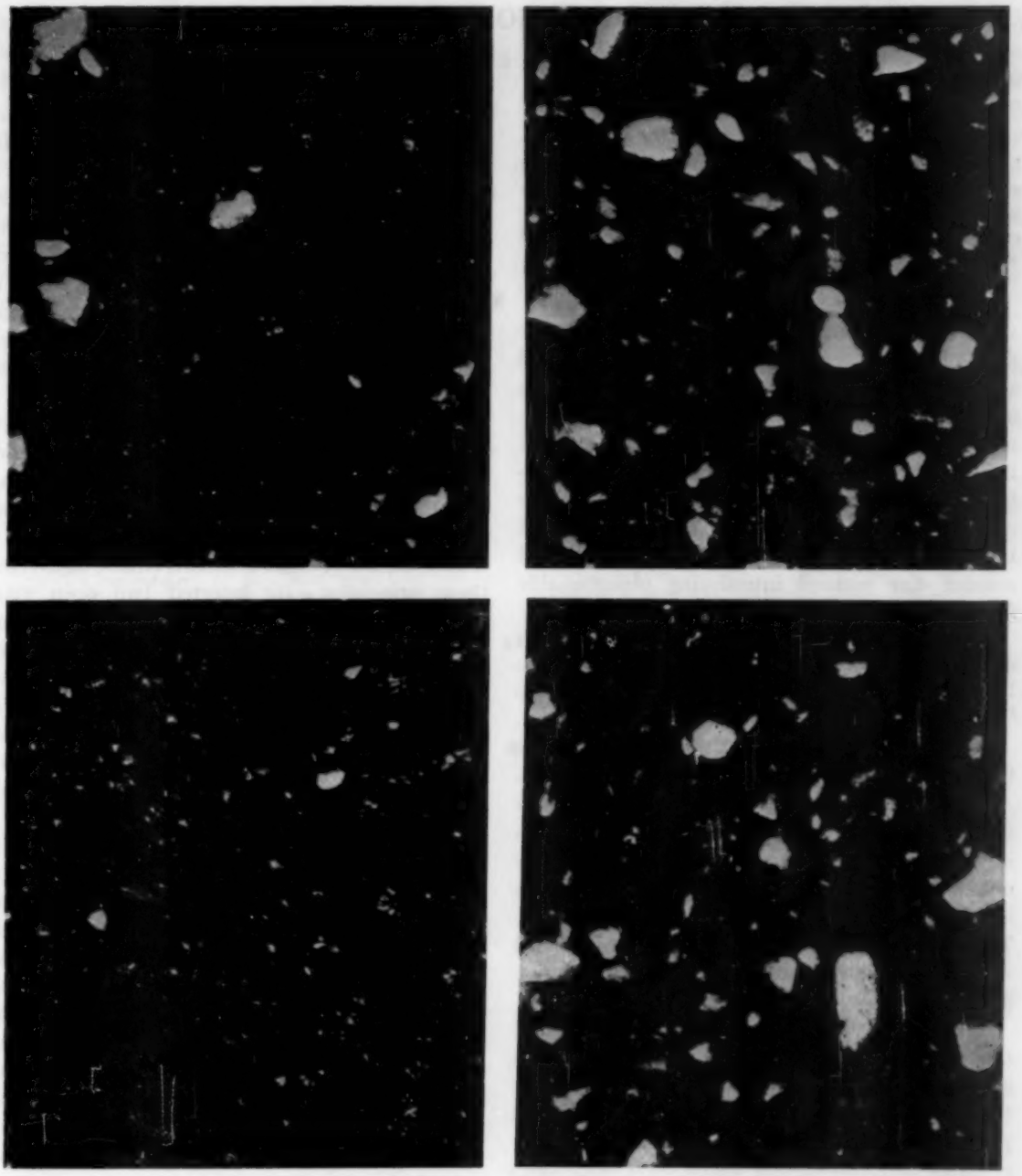

FIG. 3.—Photomicrographs: ×160, crossed-nicols; (upper left) Body No. 1, pebble flint; (upper right) Body No. 2, sand flint; (lower left) Body No. 4, tripoli flint; (lower right) Body No. 3, rock flint.

body containing rock flint over that containing sand flint is not apparent. The microanalysis shows conclusively that it is not due to differences in the amount of quartz dissolved. One explanation is a possible difference in the transparency of the flint particles themselves, causing the difference in translucency of the plates.

Acknowledgments The author wishes to acknowledge his indebtedness to C. E. Jackson of the Warwick China Company for suggesting the problem and for making and firing the plates; to V. V. Kelsey of the Consolidated Feldspar Corporation for supplying three of the samples of flint used; to J. O. Kraehenbuehl, Assistant Professor of Electrical Engineering at the University of Illinois, for help in measuring the translucency of the bodies; and to C. W. Parmelee, Head of the Department of Ceramic Engineering, and R. K. Hursh, Professor of Ceramic Engineering at the University of Illinois, for their help and interest.

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ELECTRICAL LUBRICATION OF STIFF-MUD DIES*

By J. O. Everhart

ABSTRACT

The history of the lubrication of dies and of electro-lubrication is presented, and plant and laboratory tests are given in detail. The electrolytes used, potassium hydroxide, hydrochloric acid, and ferric sulfate, are discussed. Electrical lubrication of dies is recommended with certain precautions cited in its adaptation.

I. Introduction

It has been common practice since the early days of auger machines to lubricate brick and solid block dies with oil or steam, neither of which is entirely satisfactory. Few attempts have been made to lubricate dies for forming any type of hollow ware. If any such attempts were successful it is not common knowledge. A method is needed to permit lubrication of both cores and liners of hollow-ware dies and of liners of solid column dies without introducing objectionable features of oil or steam.

Editor's Note: Many years ago electrically lubricated dies were advertised and exhibited at meetings of the N.B.M.A. They were successful, but were not adopted by the industry.

It has not been generally known that dies may be operated successfully with electro-lubrication. A few such installations have been made recently and operated with considerable success. Considering that these dies were constructed without previous experience and knowledge of the fundamentals involved, their satisfactory operation is gratifying. This method of lubrication should not be confused with electrical heating of the die, which is common practice.

Their operation is dependent upon the fact that when a current of electricity is passed through a mixture of clay and water there is a concentration of moisture at the negative electrode. This phenomenon seems to be related to those of cataphoresis and endosmosis which have long been known to physical chemists. If an electrical current is passed through a fluid mixture of water and practically any finely divided solid material, the particles tend to arrange themselves on or near the positive electrode, reducing their concentration in the vicinity of the negative electrode or cathode. This is known as cataphoresis. It is conceivable that this same action occurs in a mixture of finely divided clay particles and water in practically all proportions of water and solid material. When electrolytes are present, some of the action is probably due to endosmosis, which is illustrated by the travel of water through a porous medium away from the anode to the cathode when a sufficient potential is applied. This action is so marked that if the cathode is suspended in a porous container surrounded by water in which the anode is inserted, the water within the container will rise to a level considerably higher than that outside. In stiff-mud bodies, the clay portion probably acts as the porous medium.

In 1808, the Russian scientist, Reuss, discovered these principles. He inserted two open glass tubes in a lump of clay and after partially filling them with water inserted an electrode in each tube. He observed that the water level about the negative electrode rose and that the liquid about the positive electrode became cloudy from clay particles in suspension, indicating the travel of clay particles to the positive electrode and moisture to the negative electrode.

More progress in application has been made in several other lines than in the ceramic industry. It is used in the evaluation of the virility of bacterial cultures; purification of glues, gelatines, fruit juices, nitrocellulose, alkaloids, and serums; the extraction of sugar from beets and molasses; the separation of oil and water emulsions in the petroleum industry; the concentration of radioactive substances; sterilizing and improving food stuff; preparation of aluminum hydroxide; and waterproofing fabrics. These are only a few of the industries in which it is used. Rubber goods manufacturers are placing on the market a product called anode rubber, which is secured by the deposition of colloidal rubber from suitable suspensions on anodes of the desired shape. Agricultural experiment stations have successfully lubricated the mold boards of breaking plows in this manner.

Its present development as applied to dewatering clays may be ascribed to Count von Schwerin.[1]

* Presented at the Annual Meeting, American Ceramic Society, Cincinnati, Ohio, February, 1934 (Structural Clay Products Division). Received February 15, 1934.

This paper is a progress report of one phase of an investigation being conducted jointly by the Engineering Experiment Station and the departments of electrical and ceramic engineering at the Ohio State University.

[1] See C. E. Curtis, "Electrical Dewatering of Clay Suspensions," *Jour. Amer. Ceram. Soc.*, **14** [3], 219–63 (1931).

Several European installations are founded on his basic patents which have been improved and elaborated on from time to time.

The principle is used in filter-press operation and dewatering clay in general. Cutting wires are said to pass through the column more easily and with less deformation of the ware when they are connected to the negative terminal and the column proper to the positive. Any practice which involves contact of clay with metal, such as special shape molds for refractories, cradles for

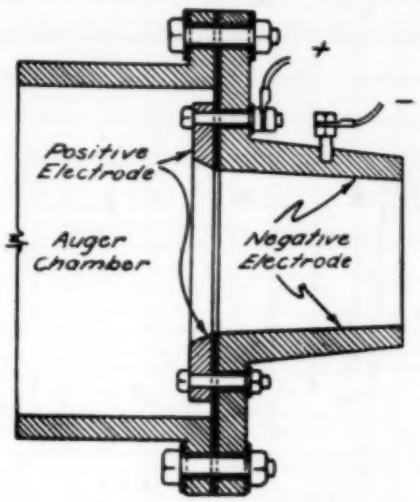

FIG. 1.—Simple solid column die, wired for electrical lubrication.

tile machines, or soft-mud brick molds, may be improved by this process, sanding or oiling of molds being unnecessary.

In construction, dies for producing stiff-mud ware need not be greatly different from the type of die used with oil or steam lubrication. Dimensions and shape of cores, liners, and bridges need not be changed materially. In fact, construction of brick dies is simplified in that the liner can be one solid piece with no provision for an oil reservoir. The only necessary additions are that of the anode, a ring of suitable shape mounted back of the die and insulated from it, and insulation of the liner from the rest of the machine (see Fig. 1).

In hollow-ware dies it is necessary to provide separate anodes for the cores and liner due to the difficulty of securing proper space relation with a common anode. Proper insulation and wiring of electrodes have offered a problem in design. Selection of a suitable insulating material has also been somewhat difficult due to heat generated, the action of electrolytes, and general carbonization of phenollythic type materials. However, this has not been as difficult as was first feared. Of correct spacing and exact location of electrodes for best results, not so very much is known. It could scarcely be hoped that dies constructed without previous experience or test data to indicate proper design would function with maximum efficiency. However, the results obtained in initial tests of the dies were promising.

II. Plant Tests

Of the commercial installations surveyed the following findings are reported:

Case 1 This die was a double-stream end cut brick die used in a chemical stoneware plant. After some minor changes a mechanically correct column was produced. While no measure-

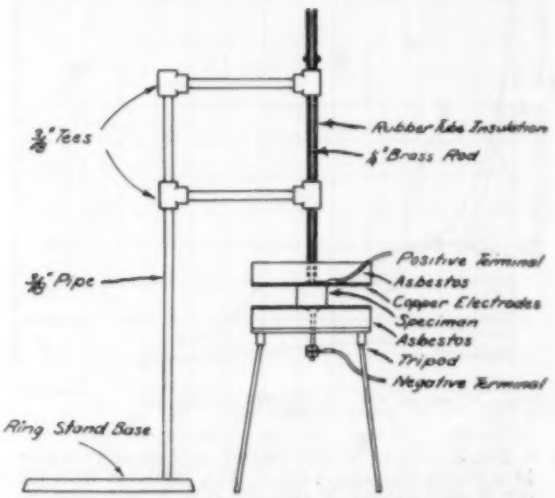

FIG. 2.—Apparatus for conducting laboratory tests.

ments were made of power consumption or rate of operation, there was noticeably less labor in the driving motor. The operators of the machine were well satisfied with the results obtained, considering it a decided improvement over oil or steam lubrication. Acids were added to the body with the result that more lubricational effect was secured.

Case 2 This was a special variation in application of the principle to a hollow-tile die of such shape that the column could only be balanced by extensive choking back of the center portion. By wiring the cores so that they became the positive electrodes and passing the currents from them to the die liner, sufficient

drying of the clay in their vicinity was obtained to eliminate the necessity of mechanical chokes. Lubricational effect at the liner was sufficient to produce a good surface and corners. This is cited to show the flexibility possible with this type of lubrication.

Case 3 This die was a single stream four-inch drain-tile die installed at the clay products plant of the Ohio State University. A metal ring was mounted around the core support just back of the core and another, slightly larger than the die opening, was placed around the entrance to the die proper. Both of these were connected to the positive terminal of a direct-current motor generator set having a capacity of 7.5 amperes at 200 volts. The core and die liner were wired to the negative terminal. With this particular die it is also possible to charge the core bridge positively.

A series of test runs was made with this die using a recording wattmeter on the driving motor. Measurements of operating speed were made with and without current applied to the die. The following data were secured after averaging the results obtained over a series of tests: (1) average increase in rate of column flow obtained by electrophoresic lubrication was 10.01%; (2) average decrease in power consumed was 22.40%; and (3) average power required to lubricate the die as shown by the motor generator was 2.47 kilowatts.

Metal molds for forming special refractory shapes have also been lubricated successfully. This application is discussed more fully in another paper.[2]

A soft-mud brick machine has been equipped for this type lubrication, but no report of its operation has been received.

It is doubtful if the decrease in power required to operate a stiff-mud machine is greater with electrolytic lubrication than with oil. From tests conducted in the past there is evidence that it will be more efficient from this angle than steam. The fact that part of the saving in power consumption is consumed by that necessary to operate a motor generator should not be overlooked. However, in most cases this will be a small item as compared to that necessary to run the auger.

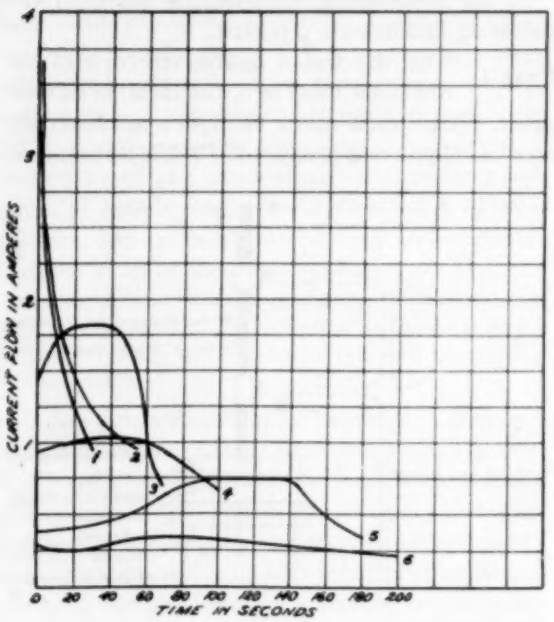

FIG. 3.—Effect of hydrochloric acid on current flow in a plastic clay body: (1) *N* HCl, (2) 0.5 *N* HCl, (3) 0.2 *N* HCl, (4) 0.1 *N* HCl, (5) 0.01 *N* HCl, and (6) distilled water.

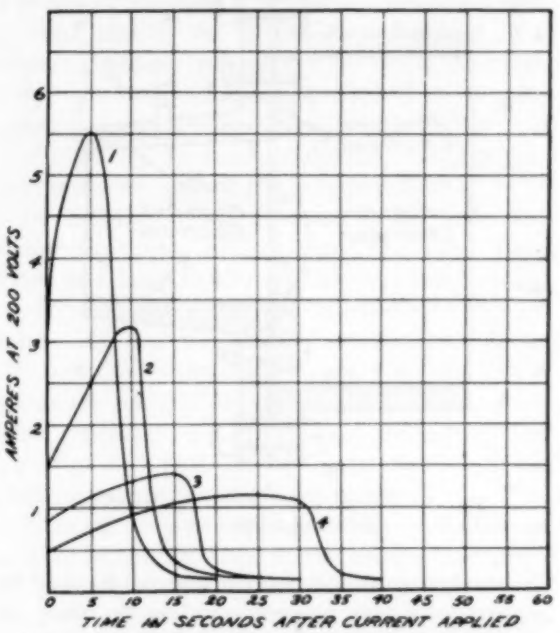

FIG. 4.—Effect of additions of hydrochloric acid on the conductivity of a stiff-mud fireclay body: (1) 5% HCl in tempering water, (2) 2% HCl in tempering water, (3) 1% HCl in tempering water, and (4) distilled water.

[2] J. O. Everhart, "Electrical Lubrication of Molds for Forming Special Refractory Shapes." Paper to be published in an early issue of the *Journal of the American Ceramic Society.*

III. Laboratory Investigations

Realizing the necessity for a general study of factors involved in applying the principle to commercial practice, a program for laboratory investigation has been outlined as follows: (1) a study of the space relation between electrodes as to flow of current and transfer of moisture; (2) a study of the effect of the presence of soluble salts and electrolytes in the body on current consumption and moisture transfer; (3) a determination of the effect of varying potential on the transfer of moisture; and (4) a study of the effect of moisture content on current passage.

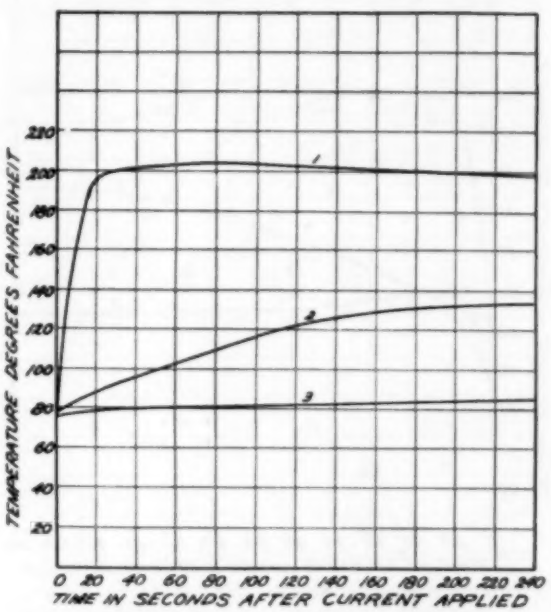

FIG. 5.—Heating effect produced by passage of electrical current through plastic Florida kaolin body tempered with a normal solution of hydrochloric acid: (1) at positive electrode, (2) at intermediate point, and (3) at negative electrode.

The following points are being investigated by the departments of electrical and ceramic engineering: (5) distribution of potential drop between electrodes; (6) residual voltage in body after interruption of current flow[3]; (7) quantitative determinations of the lubricational effect of electric current at different voltages; and (8) selection of a suitable insulating material to withstand electrolytic action and heat generated.

(1) Apparatus An apparatus for laboratory testing was constructed (see Fig. 2). It consisted of two copper electrodes mounted horizontally so that the distance between them could be varied at will. Each disk was insulated against heat loss by an asbestos base insulation.

A standard size and shape specimen was selected for all tests. They were hand-wedged in a metal cylinder of two square inches cross-section. Upon extrusion, they were cut into one-inch sections. All tests, unless otherwise noted, were made on specimens of this size. During temperature-measurement tests the specimens were wrapped about their circumference with asbestos paper.

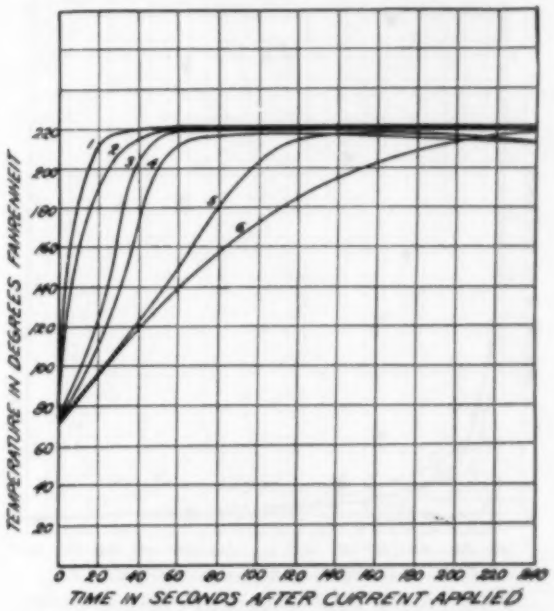

FIG. 6.—Heating effect at positive electrode with various concentrations of hydrochloric acid in the tempering water: (1) normal solution, (2) 0.5 normal solution, (3) 0.2 normal solution, (4) 0.1 normal solution, (5) 0.01 normal solution, and (6) distilled water.

Washed Florida kaolin was used because it offered a body as nearly free from natural soluble salts as could be secured. It was all ground to pass an 8-mesh screen.

(2) Effect of Electrolytes Three electrolytes have been used. They are potassium hydroxide, hydrochloric acid, and ferric sulfate. Specimens were made up with 45% tempering solution. This is, of course, more moisture

[3] It was observed that after a current has been passed through a clay body there is a small residual voltage evidenced. This is gradually dissipated over an interval of time. It is believed that this is due to adsorption of an electrical charge by the colloidal material in the clay and may be proportional to the amount of colloidal material present.

than is necessary to render the ordinary stiff-mud body workable, but is just sufficient to make the kaolin plastic enough for hand molding. Batches were made up using only distilled water, and 0.01 normal, 0.1 normal, 0.2 normal, 0.5 normal, and normal solutions of each electrolyte. A minimum of five specimens was tested from each batch in determining each property. In both current flow and heating effect tests a potential of 200 volts was used. Current flow or conductivity measurements were made every 10 seconds for 4 minutes after the current was applied. Heating-effect measurements were made every 15 seconds. Temperature was determined with an iron-constantan thermocouple insulated by dipping it in molten sulfur.

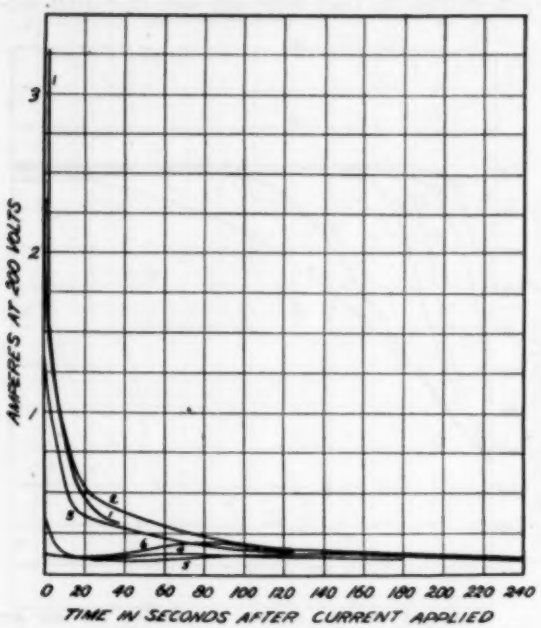

FIG. 7.—Effect of additions of potassium hydroxide on the conductivity of plastic Florida kaolin body: (1) tempering water, *N* KOH, (2) tempering water, 0.5 *N* KOH, (3) tempering water, 0.2 *N* KOH, (4) tempering water, 0.1 *N* KOH, (5) tempering water, 0.01 *N* KOH, and (6) distilled water.

(3) Distilled Water

Bodies made from distilled water and washed kaolin conducted a certain amount of current even though both ingredients alone are nonconductors. This is explained by hydroxyl-ion adsorption on the surface of clay particles. Current flow showed a tendency to increase as the body became heated until sufficient moisture had been removed from the region of the positive electrode to increase its electrical resistance to a great extent. Heating of the body at the positive electrode is slow, about 4 minutes being required to reach the boiling point when 45% tempering water was used.

A condition of strong acidity is set up in the region of the positive electrode and one of strong alkalinity at the negative electrode. Faraday observed that this phenomenon resulted when an electrical current was passed through water bearing a litmus solution. The solution became red near the positive electrode and blue near the negative electrode.

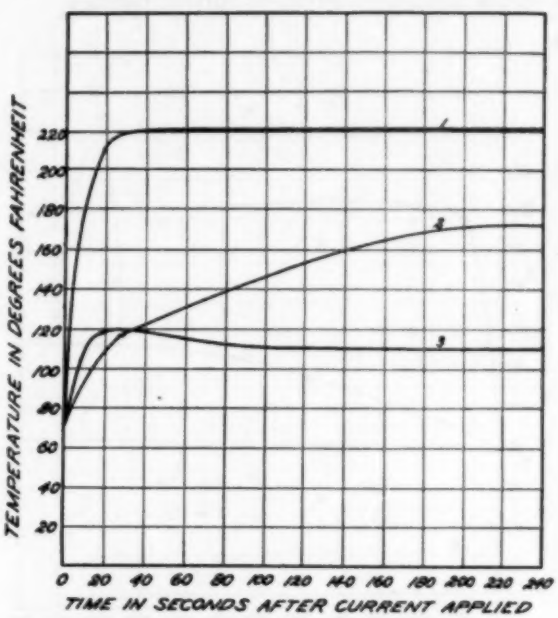

FIG. 8.—Heating effect produced by passage of electrical current through plastic Florida kaolin body tempered with a normal solution of potassium hydroxide: (1) at positive electrode, (2) at intermediate point, and (3) at negative electrode.

The condition of alkalinity may have some effect on the properties of the body, especially near the surface of the ware where it has been in contact with the negative electrode. No definite indication of this was observed except that drain tile made in an electrically lubricated machine seemed to have less scum on their surface than tile made from the same body through an unlubricated die.

(4) Hydrochloric Acid

All concentrations of hydrochloric acid gave an increase in current flow over distilled water as a tempering medium. In every case there was a sharp increase in current flow for a period of time after the current was applied, fol-

lowed by a sharp decrease as soon as sufficient moisture was removed from the region of the positive electrode to increase electrical resistance (see Figs. 3 and 4). Moisture transfer is at a greater rate when hydrochloric acid is present. Heating of the body was very rapid in the vicinity of the positive electrode. No heating except that accountable to conduction through the body was evidenced at the negative electrode (see Fig. 5). The rate of heating seems to be proportional to the amount of acid present (see Fig. 6).

The same conditions of acidity at the positive electrode and alkalinity at the negative electrode resulting when the body was made up with pure water also resulted with all concentrations of acid. They were more pronounced with increased quantities of acid.

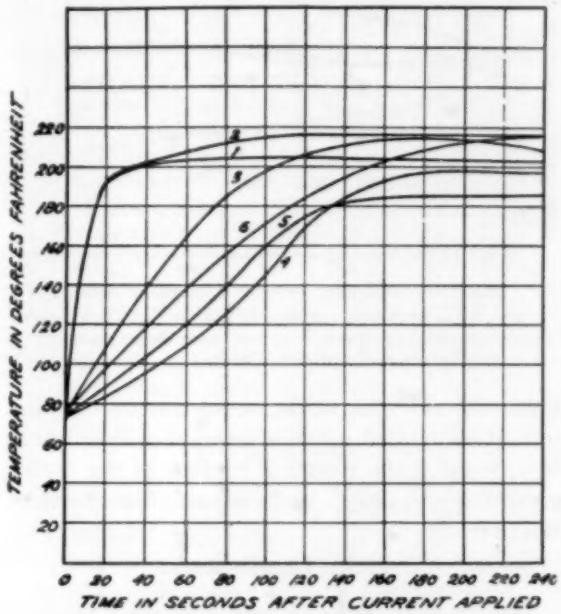

FIG. 9.—Heating effect at positive electrode with various concentrations of potassium hydroxide in the tempering water: (1) normal solution, (2) 0.5 normal solution, (3) 0.2 normal solution, (4) 0.1 normal solution, (5) 0.01 normal solution, and (6) distilled water.

(5) Potassium Hydroxide The body seems to dry in the vicinity of the positive electrode more rapidly than when acids or pure water were used. The moisture set free at the negative electrode seems to be less than with acid solutions of the same normality. The weaker hydroxide solutions show the same increase in current flow over a period of time followed by a decrease, as was exhibited by acid solutions and water alone. The stronger concentrations showed the greatest flow at the instant current was applied (see Fig. 7). They, too, probably reach a maximum sometime after the initial surge, but it follows so quickly that the instruments are only able to indicate it as an instantaneous surge.

Heating is greatest in the vicinity of the positive electrode, very little being evidenced at the negative electrode (see Fig. 8). In general, the rate of heating was faster with the stronger concentrations of hydroxide (see Fig. 9). Acid conditions were set up at the positive electrode and alkaline at the negative electrode.

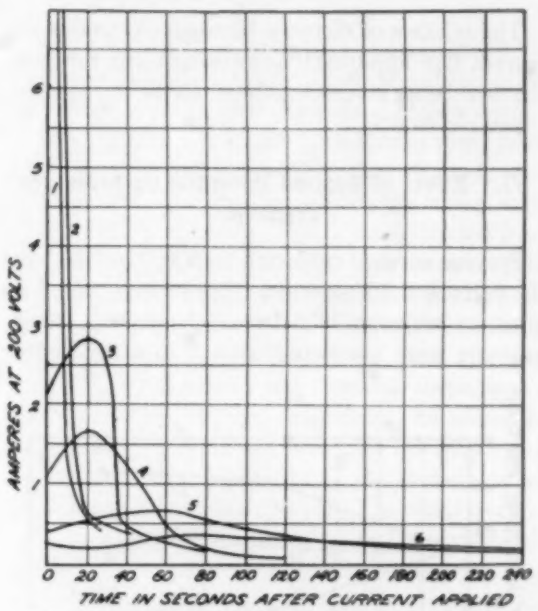

FIG. 10.—Effect of additions of ferric sulfate on conductivity of plastic Florida kaolin body: (1) tempering water, N $Fe_2(SO_4)_3$, (2) tempering water, 0.5 N $Fe_2(SO_4)_3$, (3) tempering water, 0.2 N $Fe_2(SO_4)_3$, (4) tempering water 0.1 N $Fe_2(SO_4)_3$, (5) tempering water, 0.01 N $Fe_2(SO_4)_3$, and (6) distilled water.

(6) Ferric Sulfate Maximum current flow was obtained some seconds after the potential was applied with all concentrations except the normal solution where the initial flow was indicated as the greatest (see Fig. 10). Moisture transfer was less than with either hydrochloric acid or potassium hydroxide. Heating at the positive electrode was rapid. Acid conditions were set up at the positive electrode and alkaline at the negative.

IV. Drop in Potential between Electrodes

At the time of applying current to the body, the

drop in voltage at any point between electrodes is about proportional to the distance from the positive electrode. After a few seconds' time have elapsed this relation is changed so that more than half of the total potential drop is in the first fourth of the space from the positive electrode, and about 75% of it is consumed in the half nearest the positive electrode. These proportions remain nearly constant with further passage of time.

V. Effect of Distance between Electrodes on Current Consumption

The relation of distance between electrodes and current flow apparently is a straight-line function, the flow being inversely related to the distance between electrodes.

VI. Effect of Applied Potential on Moisture Transfer

Specimens were subjected to 200, 150, 100, and 50 volts for 10 seconds. They were cut into quarters horizontally between electrodes. These quarters were numbered from 1 to 4 proceeding

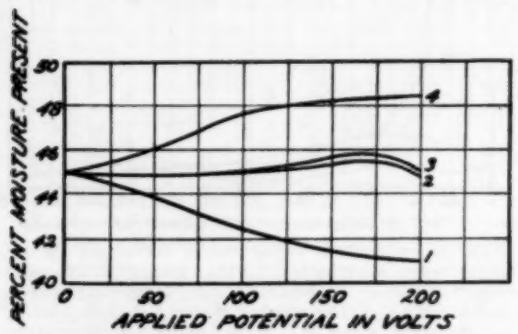

FIG. 11.—Relation between voltage and moisture transfer in a plastic Florida kaolin body; moisture content of body 45.0%; distance between electrodes 1 inch.

from the positive to negative electrode. Moisture content of each quarter was determined after the current had been applied for 10 seconds. Ten specimens were used for each test. There was little moisture change in the center portions of the body. The decrease at the positive electrode was about equal to the increase at the negative electrode (see Fig. 11).

VII. Effect of Time on Moisture Transfer

Specimens were subjected to 200 volts for time intervals of 5, 10, 15, 20, and 30 seconds. Each specimen was divided into four equal sections between electrodes and numbered from 1 to 4, proceeding from the positive to the negative electrode. Moisture content of each section was determined. Ten specimens were used for each test. There was little moisture change in the two center sections during the 30-second interval.

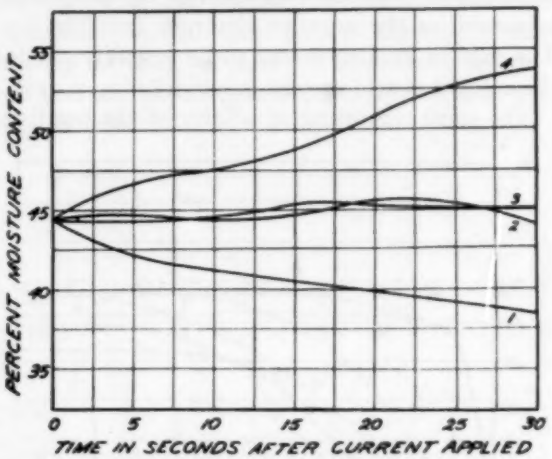

FIG. 12.—Moisture transfer in plastic Florida kaolin; fixed potential of 200 volts; moisture content 44.4%; distance between electrodes 1 inch.

From observations made on specimens in other tests it seems that a longer interval of time would have reduced the moisture content in the center sections, especially that nearer the positive electrode.

VIII. Conclusions

(1) It is possible to lubricate effectively all types of stiff-mud dies now in use unless the number of cores is so great as to make the wiring problem too complicated. The efficiency of electrical lubrication is nearly as great as when oil is used and is believed to be as good or better than steam, while some of the objectionable features of each are eliminated.

(2) The presence of electrolytes increases current flow and moisture transfer. When high concentrations (about normal solutions) of electrolytes are used, heating the anode (positive electrode) is very rapid and the moisture transfer efficiency is somewhat reduced. Additions of hydrochloric acid might well be made to clays low in soluble salts. Neither potassium hydroxide nor ferric sulfate is recommended.

(3) There is some evidence that the tendency to scum is slightly reduced when ware is made in an electrically lubricated die.

(4) For most efficient operation the positive electrodes should be close to the liners and cores. When rate of operation is fast, higher voltages are recommended. When the column flow is slow a lower voltage may be used.

(5) It is inadvisable to construct dies of this type without consulting an organization having had some experience in their construction. The problems of insulation and design are too involved for amateur construction to secure the greatest efficiency.

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FURTHER STUDIES OF THE TUNNEL KILN*

By W. D. Richardson

ABSTRACT

Reasons are given as to why the tunnel kiln seems to be the best type of kiln for structural clay products. The downdraft tunnel kiln is the most efficient and most practical form of kiln for most clay products.

The improvements made in the Richardson downdraft tunnel kiln are described. Recent improvements in the flat suspened arch are described and illustrated and improvements in car frame, car platform, and baffle are given.

A new tunnel kiln, the Richardson muffle-car, double-track tunnel kiln, is also described and illustrated. This kiln is thought to be well adapted for floor and wall tile and some pottery, saving in handling and breakage of saggers.

I. Introduction

The tunnel kiln is the most economical kiln for all structural clay products. The saving in fuel is no more than could be attained with some other forms of continuous kilns, but there is better distribution of heat throughout the ware and better control of temperatures, resulting in a large decrease in underfired, overfired, and off-color ware to be disposed of at a loss. Since a previous paper of the writer,[1] an improvement of the downdraft tunnel kiln has been made.

II. The Flat Suspended Arch

The flat suspended arch is the most durable and practical arch for tunnel kilns, as it is for all rectangular kilns. The suspended arch consists of two forms of refractory brick or blocks, one a suspension member and the other supported on this member, the former having a 3-inch hole horizontal through the upper part, into the center of which a vertical 3-inch hole extends from the top of the block. Into the horizontal hole, under the entrance of the vertical hole, is placed a pin or bar, preferably a $^3/_4$-inch extra-strong pipe, passing through a $^5/_8$-inch eye bolt that depends from a pair of steel channels resting on the tunnel walls at a sufficient height to insure no deflection from heat. The channels are on 30-inch centers. The recent improvements in this arch are the projecting of the suspension members above the bearing members so that the supporting pins are protected by circulation of air through them, and a sufficient space between the blocks to allow for expansion, no mortar being used in the entire construction, and provision being made to seal all joints effectively with asbestos or mineral wool to prevent escape of gases. The bearing members of the arch may be covered with insulating material, or the heat radiated from the crown of the firing zone may be utilized in the watersmoking zone or in the drier or for heating rooms of the building. Figure 1 shows a cross-section of one half of the suspension members and in the other half the supporting members. Over the preheating zone and over the cooling zone cheaper forms of arch are used. Figure 2 shows a longitudinal elevation of the arch, with one drop arch and the automatic damper.

III. The Car Draft Flues

Another improvement has been in the design of the car frame so as to permit larger draft flues and a thicker insulation under the flues. A simpler way has also been devised for dampering the draft flues, between the watersmoking and preheating zones, between the firing and the cooling zones and, when saltglazing, between the last compartment of the firing zone and the one

* Presented at the Annual Meeting, American Ceramic Society, February, 1934, Cincinnati, Ohio (Structural Clay Products Division). Received December 26, 1933.

[1] W. D. Richardson, "Application of the Downdraft Principle to Tunnel Kilns," *Jour. Amer. Ceram. Soc.*, **14** [8], 572–77 (1931).

behind it, thus permitting the operation of the saltglazing compartment without interfering with the operation of the rest of the kiln. The baffle at the rear end of every other car (about every 20 feet) has been made to take up less space. The refractory blocks are interlocked. Figures 1 and 2 show these improvements in sufficient detail for the present purpose.

The cars are moved through the tunnel intermittently by pushing a ten-foot car into the tunnel in 5 to 10 minutes and immediately following with another car. The tilting damper on the baffle of the second car registers with the drop

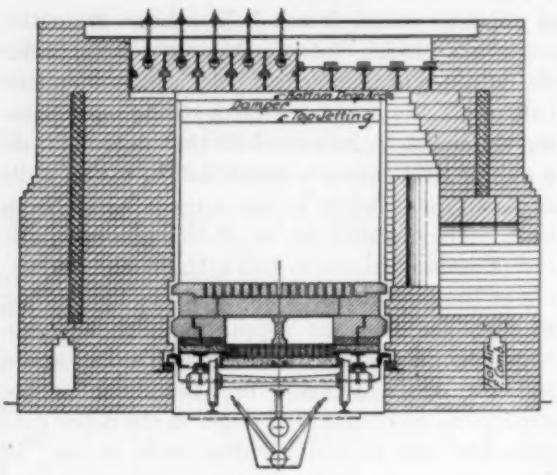

FIG. 1.*

arch. A long car costs less per ton of load than a short car, and the longer wheel base causes less friction of the wheel flanges on the rails.

IV. A Car-Muffle Double-Track Tunnel Kiln

Noting various patented designs for the mechanical movement of ceramic ware through small muffle tunnel kilns, much study has been given to such kilns and means of conveying the ware through them and to the "up- and down-" shaft kiln. The conclusion was finally reached that the cheapest and most practical method is on cars designed for the special purpose and propelled through the tunnel by the approved hydraulic pusher. The chief features of the design of such a kiln are shown in Figs. 3, 4, 5, and 6.

* Since the presentation of this paper, an improved method of air-cooling of car bottoms has been devised.

The muffles or setting boxes are built up of thin tile of a refractory material that is strong, durable, and a good conductor of heat, such as silicon carbide. These tile are jointed by tongue and groove and each box braced by special firebrick shapes. The open end of the box is not exposed to the direct action of the fires. The open ends of the boxes on the twin cars face the narrow space between the cars. As the cars are necessarily narrow, not more than 24 inches wide, the tunnel has two tracks, each pair of cars being pushed through the tunnel together. The cars

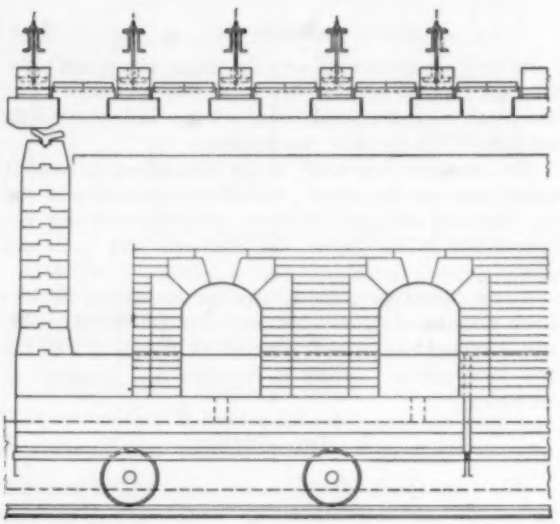

FIG. 2.

are taken to and from the tunnel on a double-track transfer car, but outside of the tunnel the return tracks are separated far enough apart (the open ends of the muffles facing each other) to permit being set from an overhead monorail or other conveyer between the tracks. Figure 3 shows the construction of the muffle car.

With the flat suspended arch that can not sag, the top bracing brick between the boxes (and projecting above them) can safely operate within an inch of the arch, thus checking longitudinal draft over the top of the cars. Hence, the draft on the tunnel is across the cars through the spaces between the boxes, top, bottom, and sides, into the draft flues in the tunnel walls. Figure 4 shows a section of the firing zone; Fig. 5, a section through the entrance of the draft flues into the preheating zone; and Fig. 6, a horizontal longitudinal section of the tunnel, the arrows indicating the passage

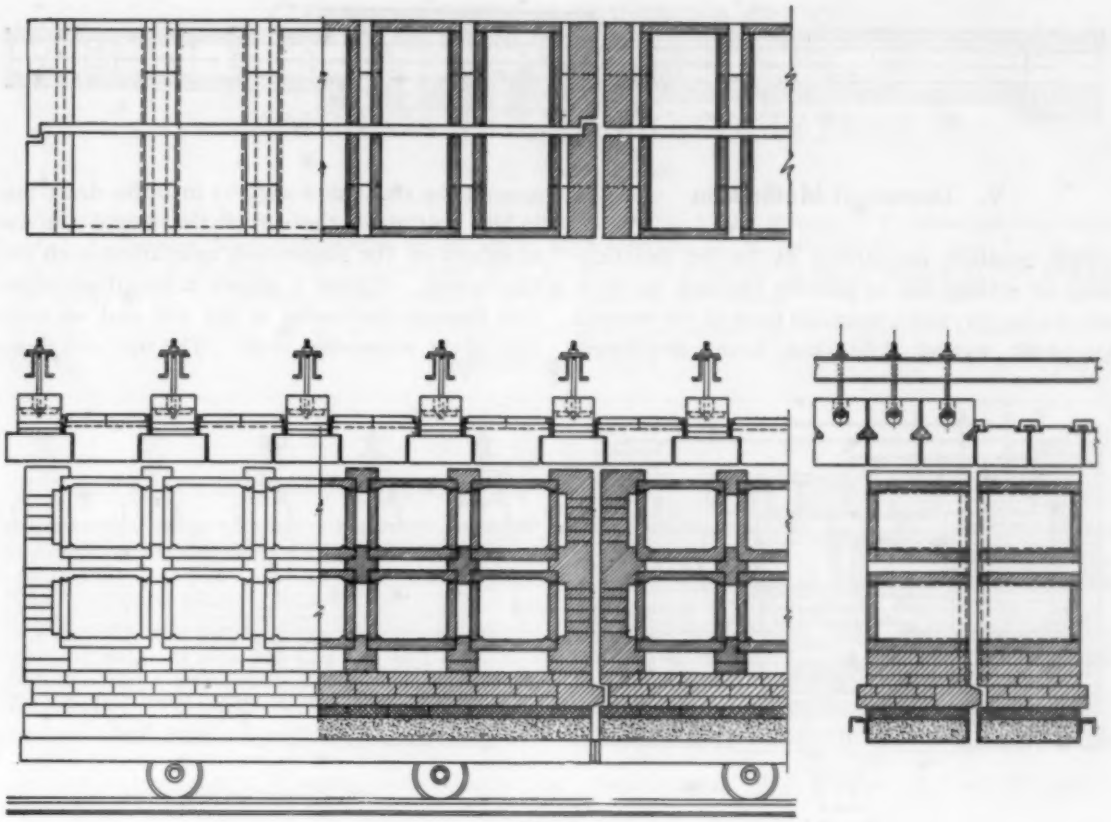

FIG. 3.

of the gases through the preheating zone to the outlet to the fan.

It is thought that this kiln is well adapted for floor and wall tile and other whiteware, saving the handling and breakage of saggers. The boxes, of course, may be made of such dimensions as would be best in any special case. This kiln could also be modified for roofing tile and promenade or quarry tile. The furnace would be adapted to the fuel, which may be natural gas, producer gas, or oil, the air for combustion being preheated from the cooling zone or by heat radiated from the crown over the firing zone.

The details of this kiln have been carefully worked out, though the presentation here covers only the main special features. In any case such designs are often conducive to improved methods.

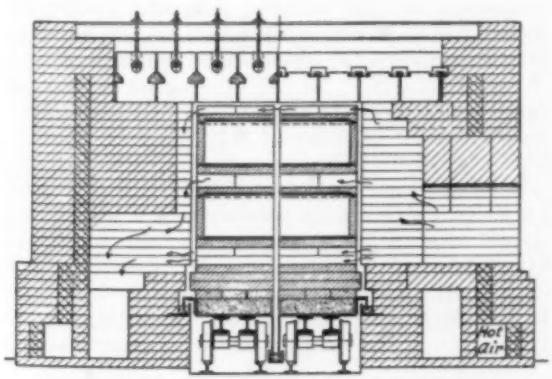

FIG. 4.

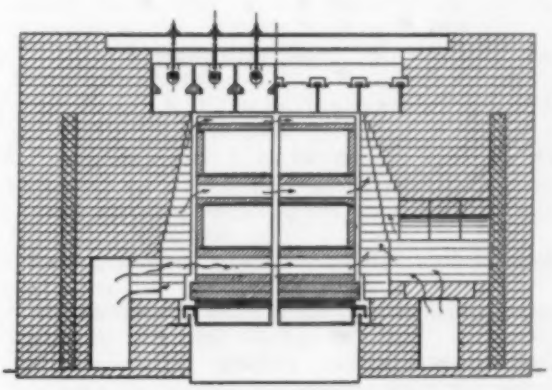

FIG. 5.

FIG. 6.

V. Downdraft Muffle Kiln

The question has arisen as to the practicability of setting tile or pottery through an open end of a sagger, and a modified form of the writer's downdraft tunnel kiln has been developed, adapted for stationary saggers or car muffles, dovetailed boxes, braced with special shapes of brick, the covers being removable. Figure 7 is a cross-section of this kiln in the firing zone, showing the circulation of the hot gases entirely around the stationary saggers into the draft flues in the bottom of the car platform and the two members of the suspended, mortarless arch over the tunnel. Figure 8 shows a longitudinal section through the center of the car and an elevation of the suspended arch. The up- and down-

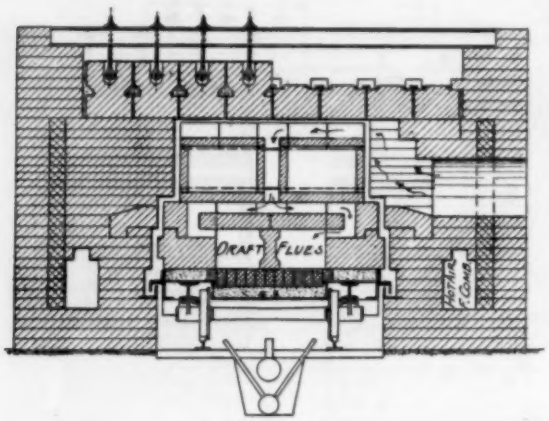

FIG. 7.[1]

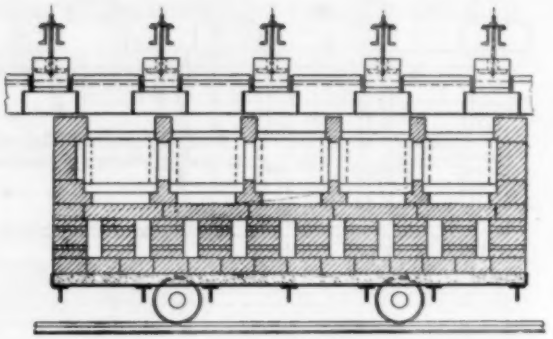

FIG. 8.—Section *a–b* of car.

circulation of the gases in the preheating zone is practically the same as with the large downdraft tunnel kiln, the cars coming into the firing zone with hot bottoms.

[1] See footnote * to Fig. 1.

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CERAMIC ABSTRACTS[1]

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Vol. 13 **September, 1934** **No. 9**

Abrasives

Abrasive-belt sheet grinder. Mattison Machine Works. *Metal Cleaning & Finishing*, **6** [6], 320 (1934).—A detailed description of a new grinder for grinding alloy, carbon, and other forms of sheets, employing factory-coated abrasive belts manufactured under controlled conditions, is presented. Illustrated. E.J.V.

Use of abrasive sleeves and belts. Fred B. Jacobs. *Metal Cleaning & Finishing*, **6** [6], 314–15 (1934).—The procedure to be followed in the application of various types of coated abrasive belts and sleeves to the polishing of metal products is presented. Advantages of abrasive belts and sleeves are listed. E.J.V.

PATENTS

Abrading and polishing composition. P. A. Patterson (McAleer Mfg. Co.). U. S. 1,965,299, July 3, 1934.

Abrasive articles bonded with a synthetic resin. Bakelite, Ltd. (Carborundum Co.). Brit. 411,846, June 27, 1934.

Abrasive or polishing roll. E. A. Filley (Wingfoot Corp.). U. S. 1,963,357, June 19, 1934.

Abrasive structure. M. J. Schneider. U. S. 1,963,154, June 19, 1934.

Abrasive tool. O. S. Buckner. U. S. 1,963,823, June 19, 1934. An abrading tool having a circular, peripheral working face is composed of a rigid, bonded mass of abrasive grains, a substantial portion of which are of elongated formation and are mainly arranged with their longer dimensions extending approximately radially with relation to the center of the face.

Art of grinding. Willetts Peaslee (Cincinnati Grinders, Inc.). U. S. 1,965,256, July 3, 1934. A grinding wheel for operation at a constant prescribed number of revolutions per minute comprises a composition of an abrasive material and a bond therefor, the grit and grade of the composition material progressively, continuously decreasing from center to the periphery of the wheel whereby the wheel when operated at constant r.p.m. will perform a prescribed grinding irrespective of reductions in diameter of the wheel resulting from wear, truing, etc.

Ball grinding machine. G. F. Matteson (Abbott Ball Company). U. S. 1,964,165, June 26, 1934.

Buffing machine. R. E. Duplessis (United Shoe Machinery Corp.). U. S. 1,964,043, June 26, 1934.

Buffing wheel, buffing wheel fabric, and method of treating the fabric. K. H. Barnard (Pacific Mills). U. S. 1,964,901, July 3, 1934.

Combined internal and face grinding machine. Fortuna-Werke Spezialmaschinenfabrik A.-G. Brit. 412,523, July 4, 1934.

Form grinding. S. J. Harley. Brit. 412,462, July 4, 1934.

Grinding disk. I. R. Shue (Gardner Machine Co.). U. S. 1,964,537, 1,964,538, and 1,964,539, June 26, 1934.

Grinding machine. Walter Ferris and J. P. Ferris (Oilgear Co.). U. S. 1,965,696, July 10, 1934. W. J. Guild and H. L. Blood (Heald Machine Co.). U. S. 1,964,433, June 26, 1934. F. S. Haas (Cincinnati Grinders, Inc.). U. S. 1,965,234 and 1,965,235, July 3, 1934. C. L. Schulte (Cincinnati Grinders, Inc.). U. S. 1,965,261, July 3, 1934. G. F. Yager (Bunting Brass & Bronze Co.). U. S. 1,966,194, July 10, 1934. R. W. Young (Charles H. Besly & Co.). U. S. 1,965,020, July 3, 1934.

Grinding of rotating eccentric knives. W. E. Molins. Brit. 411,440, June 20, 1934. W. E. Molins, F. F. Ruau, F. W. Hacking, and Molins Machine Co., Ltd. Brit. 412,222, July 4, 1934. E. C. Muhlbauer and Molins Machine Co., Ltd. Brit. 411,244, June 13, 1934.

Grinding of safety-razor blades. V. R. Cam. Brit. 412,223, July 4, 1934.

Grindstone. R. E. Read (International Paper Co.). U. S. 1,963,247, June 19, 1934.

Honing apparatus. J. H. Gettig and A. D. Gettig (National Tube Co.). U. S. 1,963,620, June 19, 1934.

Internal grinding and cutting tool. J. W. Bailey. U. S. 1,966,277, July 10, 1934.

Lapping machine. J. G. H. Budd. U. S. 1,963,884, June 19, 1934.

Manufacture of abrasive articles. F. A. Upper (Bakelite Corp.). U. S. 1,963,253, June 19, 1934.

Manufacture of grinding and abrading bodies. Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler. Brit. 411,498, June 20, 1934.

[1] The bold-face number following the journal is the volume, the issue number is in brackets, followed by the page numbers, then the year in parentheses.

Means for shaping and truing the operating surfaces of grinding wheels used for form grinding. S. J. HARLEY. Brit. 412,464, July 4, 1934.

Method and apparatus for lapping gears. HERMANN JACKOWSKI (W. Ferd). U. S. 1,966,172, July 10, 1934.

Method of grinding straight and helical teeth on spur wheels. PAUL UHLICH (Deutsche Niles Werke A.-G.). U. S. 1,964,233, June 26, 1934.

Method of making an article of shellac-bonded abrasive material. D. E. WEBSTER (Norton Co.). U. S. 1,965,016, July 3, 1934.

Method of making a grinding disk. I. R. SHUE (Gardner Machine Co.). U. S. 1,964,540, June 26, 1934.

Scissors sharpener. L. H. GAW. U. S. 1,964,627, June 26, 1934.

Tool grinder. ISIDOR YASSENOFF. U. S. 1,963,394, June 19, 1934.

Tool for grinding valve seats. L. O. BEARD. U. S. 1,964,240, June 26, 1934.

Art and Archeology

BOOK REVIEW

The Potter's Art. CIPRIANO PICCOLPASSO (1524–1579). Translation and Introduction by Bernard Rackham and Albert van de Put. xxii + 85 pp., 80 plates. Victoria and Albert Museum, London, 1934. Price $10.00, from W. A. Weldon, 621 Edgewood St., Baltimore, Md. The Potter's Art, printed for the first time in the exact words of the original, is accompanied by a translation in English and contains all the drawings in the manuscript reproduced in collotype plates.

The transcription is from a manuscript in the National Art Library of the Victoria and Albert Museum, London. This manuscript is the only contemporary record of the technical processes used in making Italian majolica. It was written about the middle of the 16th Century.

The secrets of the potter's art or craft of Piccolpasso's period in Italy are told in this manuscript. It deals only with two classes of earthenware, majolica and graffito. Graffito, a lead-glazed ware made at Bologna and Citta di Castello, was decorated by cutting or scratching the design through a coating of white clay laid over red or buff clay. Majolica, an earthenware coated with a glaze or enamel rendered opaque by the inclusion of tin, was introduced in Italy from the Near East in the 14th Century or earlier. The progress made in the production of majolica and the development of the different glazes used are shown. The first book contains the manner of obtaining, beating, separating, and straining the clay. The manner of making ware without a mouth is fully explained. The text and illustrations show how they are made and put together. The second book is devoted mostly to the making of glazes. The materials, proportions, and processes used in making the various glazes are told. Plans for building a pottery kiln are included and explained in the text. The manner of setting and firing ware is explained. The mills used in grinding pigments for glazes are also discussed. The third book tells of the order to be observed in firing and grinding all the colors. ISOLANDO DEL SIGNORE

PATENTS

Designs for:

Bottle. H. A. ALLERS. U. S. 92,509, June 19, 1934. J. W. BICKS (Carr-Lowrey Glass Co.). U. S. 92,697, July 10, 1934. W. J. DU BREE. U. S. 92,647, July 3, 1934. A. B. CASSEDY. U. S. 92,521, June 19, 1934. E. W. FUERST (Owens-Illinois Glass Co.). U. S. 92,717 and 92,718, July 10, 1934. G. J. GRAHAM. U. S. 92,532 and 92,533, June 19, 1934. W. R. LEACH (Carr-Lowrey Glass Co.). U. S. 92,542, June 19, 1934. A. C. MEYER (Glenshaw Glass Co.). U. S. 92,544, June 19, 1934.

Cooking stove. B. B. KAHN (Estate Stove Co.). U. S. 92,539, June 19, 1934. SAMUEL KLUTE (Malleable Steel Range Mfg. Co.). U. S. 92,540, June 19, 1934.

Cooking range. A. O. SPOENEMAN. U. S. 92,681, July 3, 1934.

Electric lighting unit. R. G. COWAN (Pass & Seymour, Inc.). U. S. 92,702, July 10, 1934.

Flask. D. E. BRINER (Hazel-Atlas Glass Co.). U. S. 92,518, June 19, 1934.

Gas range. W. T. BRADBURY (Florence Stove Co.). U. S. 92,577, June 26, 1934.

Plate. DORIS JOHNSON (Mayer China Co.). U. S. 92,604, June 26, 1934.

Tumbler. C. A. HICKMAN. U. S. 92,655, July 3, 1934.

Electrically conducting coating on vitreous substances and method of producing. J. F. HYDE (Corning Glass Works). U. S. 1,964,322, June 26, 1934. (1) The method of producing an electrically conducting coating on vitreous substances includes treating the vitreous substance with the vapor of silicon tetrachloride and heating it under reducing conditions. (2) A vitreous article coated with an electrically conducting film of variable conductivity is obtained by treating the heated article with the vapor of silicon tetrachloride and heating it under reducing conditions.

Cements

Chemical constitution of Portland cement clinker. W. WATSON AND Q. L. CRADDOCK. *Cement & Cement Manuf.*, **7** [6], 169–77 (1934).—Later theories are discussed concerning solid solution to account for $3CaO \cdot SiO_2$ and compounds containing Al and Fe. The forms of magnesia and manganese in clinker are treated. The most abundant compounds in 25 commercial clinkers examined by X-ray methods are tricalcium and β-dicalcium silicates. In addition there are normally present $3CaO \cdot Al_2O_3$, $4CaO \cdot Al_2O_3 \cdot Fe_2O$ and $MgO \cdot 5CaO \cdot 3Al_2O_3$, the latter occurring in cements of high alumina content. So id so utions of $2CaO \cdot Fe_2O_3$ and $4CaO \cdot Al_2O_3 \cdot Fe_2O$ and Fe_3O_4 may also occur. Free CaO is not usually present except in very small amounts. G.R.S.

Heat of hydration of cement and its constituents. I. O. F. HONUS. *Cement & Cement Manuf.*, **7** [6], 157–68 (1934).—The constituents of cement combine chemically with water to form hydroxides, hydrosilicates, hydroaluminates, and hydroferrites. The unstable tricalcium si icate, the compound richest in lime, is first decomposed into dicalcium silicate and $Ca(OH)_2$, and in about the same time the tricalcium aluminate is converted into tricalcium hydroaluminate. There follows decomposition of the dicalcium silicate (resulting mainly from the tricalcium silicate) into dicalcium hydrosilicate and $Ca(OH)_2$. The hydration of the dicalcium ferrite and dimagnesium silicate concludes the combination with water, with the separation of $Ca(OH)_2$ and $Mg(OH)_2$ and the formation of calcium hydroferrite and magnesium hydrosilicate. A schematic representation and explanation of the hydration of Portland cement is given. The thermochemical reactions are e ucidated, illustrating the method of calculating the heat content of any Portland cement. The heats of solution of all oxides connected with cement and of their hydration products are given. G.R.S

International dictionary of cement. C. R. PLATZMANN. *Cement & Cement Manuf.*, **7** [6], 185–88 (1934).—Spanish, French, English, and German terms from H to R are given. For A to E see *Ceram. Abs.*, **12** [12], 413 (1933). G.R.S.

PATENT

Process of producing a uniformly colored cement. A. L. ASHER AND W. C. MEYER. U. S. 1,963,540, June 19, 1934. (1) A step in the process of manufacturing a uniformly colored cement consists in grinding cement clinker to produce cement, continuing the grinding to a point where the cement will float in a like gaseous medium of equal velocity with the coloring matter employed, and then mixing the medium with the coloring matter.

Enamels

Architectural uses of porcelain enamel. BENNETT CHAPPLE. *Better Enameling*, **5** [6], 13 (1934).—Unusual opportunities exist in the architectural field for the use of porcelain enamel as a finish. E.J.V.

Correct design with respect to shape and pouring. J. KUESTER. *Giesserei*, **21** [19–20], 195–200 (1934).—Cooperation between designer and foundry is emphasized. Examples illustrate (correct and incorrect design given side by side) how by correct design cheaper and simpler castings can be produced which are also safer, as interior stresses due to shrinking, rate of cooling, or impossibility of gas to escape can be avoided. M.H.

Determination of alumina in steel. P. KLINGER AND H. FUCKE. *Arch. Eisenhüttenwesen*, **7**, 615–25 (1934).—Methods used in analyzing the alumina content of steel are compared. Samples have been tested by different methods using both low and high carbon steels. The chlorine evaporation and the hydrochloric acid solution methods are of special interest, the latter being somewhat easier to perform and less expensive than the chlorine method. W.M.C.

Development of a continuous vitreous enameling furnace. II. FREDERICK S. MARKERT. *Enamelist*, **11** [9], 15–18 (1934).—A detailed description of the first U-type oil-fired furnace and a comparison of the results obtained with it and with the ordinary box-type furnaces is presented. Illustrated. For Part I see *Ceram. Abs.*, **13** [8], 200 (1934). E.J.V.

Fourth dimension in architecture. WILLIAM REICHERT. *Better Enameling*, **5** [6], 4–5 (1934).—The use of porcelain enamel panels in remodeling a Chicago building, eliminating the old galvanized iron bays, is described. Illustrated. E.J.V.

Making enameled steel tubs for washing machines. E. F. ROSS. *Steel*, **94** [4], 23–25 (1934); abstracted in *Metal Cleaning & Finishing*, **6** [6], 308–309 (1934).—R. describes the works at the Youngstown Pressed Steel Co., Warren, Ohio, for producing enameled steel tubs used in the washing machine industry, tracing the various steps in the process of manufacture. E.J.V.

Management methods for enamel-plant cost control. II. Budgets. ROY E. DYBVIG. *Better Enameling*, **5** [6], 18–19 (1934).—In planning budgets the time period must not be too long because business conditions change rapidly. The sales budget should be based on the plant capacity with consideration of external conditions and seasonal influences. The p'ant budget shou d be coördinated with the sales budgets. The labor budget shou'd be made to correspond with the factory pay-roll period. Expense and material budgets should also be set up. Budget control, properly established, will bring results not only in profit but in a better control of organization activities. For Part I see *Ceram. Abs.*, **13** [8], 226 (1934). E.J.V.

Method and apparatus for de-enameling. CLAYTON S. HOUPT. *Enamelist*, **11** [9], 11–12 (1934).—As acids not only remove the enamel but eat into the metal base they can not be used. Various hydroxides have been found to be cheaper, work more efficiently, and dissolve the vitrified enamel or porcelain without injuring the metal base. When heated to the correct working temperature in a vat this solution brings good results in the relatively short time of 30 min. to $1^1/_2$ hr., depending on the thickness of the metal and enamel coating. Due to the formation of a sludge the action of the bath is slowed down so methods of removing the sludge had to be developed. A pump sucks the sludge out of the bottom of the vat with associated solution into an apparatus that separates the two and permits the purified solution to be returned to the tank. E.J.V.

Methods for testing and control work in the enameling plant. ROY D. BECK. *Ceram. Ind.*, **22** [7], 373–75 (1934).—Common-sense suggestions on how to cut down production losses and rejects covering milling, dipping, pickling, and other processes are offered. E.J.V.

Porcelain enameled metal. BERNARD J. MCGARRY. *Amer. Architect*, **141** [2606], 34–35 (1932).—A description of this new building material is given, together with examples of its use in actual practice. Illustrated. E.J.V.

Porcelain enamel survives fire. ANON. *Better Enameling*, **5** [6], 6–7 (1934).—Following the Chicago Stockyards fire in which 80 acres were burned, porcelain enameled signs

were found to be in good condition and were salvaged. Illustrated. E.J.V.

Prospective developments in enameling. A. I. ANDREWS. *Ceram. Ind.*, **22** [7], 370 (1934).—One-coat enamel, unfritted enamel, patching enamel, lower temperature enamels, and use of different types of steel, etc., for the future, are discussed. E.J.V.

Relations between manganese, silicon, and carbon in the production of steel. Experiments in the laboratory and in the plant. F. KOERBER. *Stahl & Eisen*, **54** [22], 535–43 (1934).—Phase diagrams have been established between molten iron, molten ferrous oxide and manganous oxide silicates, and solid silica. Equilibria were found which will permit the determination of the deoxidation of molten iron-containing oxides by manganese and silicon. The products of deoxidation may be obtained from the phase diagrams. Laboratory experiments have been carried out regarding the formation of carbides in iron melts and the changes occurring in melts of metal and slag. The rôle of carbon was investigated in the reactions between metal and slag. A number of open-hearth melts proved the great influence of the carbon taking part in the reactions. Phase diagrams will allow the prediction of the reactions taking place in steel furnaces and the equilibria to be obtained. W.M.C.

Rubber-covered door. R. L. CAWOOD. *Enamelist*, **11** [9], 20–21 (1934).—After discussing the use of rubber covered doors for pebble mills for the past three years, C. describes a newer type that eliminates many objectionable features of the older type. Instead of requiring an entirely new door frame in making repairs, the new door frame has a replaceable flange, and the door itself is built in two sections consisting of a soft rubber-covered renewable block attached to the main door section which takes the impact action of the grinding media. Illustrated. E.J.V.

Technical and market development through an educational bureau of the Porcelain Enamel Institute. EMERY L. LASIER. *Better Enameling*, **5** [6], 11–12 (1934).—L. reviews the activities of the Institute for the past three years and suggests forming an educational and technical research bureau under the auspices of the Institute. E.J.V.

Uses of soft water in the pickling process. AUSTIN KELLY. *Clay Prod. News*, **7** [6], 4 (1934).—A water softener was installed in an enameling plant using exceptionally hard water. Softened water reduced cleaner costs 20% and improved neutralizing. Hard water was shown not to be the cause of copperheading conditions. G.H.S-S.

Water booth. WILLIAM J. MISKELLA. *Ind. Finishing*, **10** [6], 11–13 (1934).—M. describes spray booths equipped with water sprays in the exhaust system for settling solids and preventing their exhaust to the outside. They are desirable for vitreous enamel spraying because they not only control objectionable dust but also reclaim enamel usually lost. Cleaning costs are reduced both inside and outside the building as well as in the exhaust system. Two sets of opposed water sprays are used, one set directed with and one against the air flow. Eliminator plates remove free water from the discharged air at low velocity insuring that a minimum of water passes out of the booth. Illustrated. J.L.G.

PATENTS

Building construction. G. G. ELLITHORPE AND C. J. MENKEN. U. S. 1,965,282, July 3, 1934.

Enameling process. A. KREIDL. Brit. 411,380, June 13, 1934.

Supporting member for enameling racks. T. H. NELSON. U. S. 1,963,242, June 19, 1934.

Wall tile fastening. A. W. NELSON (Columbian Enameling & Stamping Co.). U. S. 1,965,041, July 10, 1934.

Glass

Behavior of the glass electrode in connection with its chemical composition. B. LENGYEL AND E. BLUM. *Trans. Faraday Soc.*, **30** [6], 461–71 (1934).—The electrometric action of glass films of different compositions was investigated in acids and in different sodium-ion buffers by the usual method. The characteristic differences in the behavior of two commercial glasses were determined. The action of the two was found to be typical of several glasses investigated. $Na_2O{\cdot}CaO{\cdot}SiO_2$ glasses react practically only on the H ions, while with 10% additions of B_2O_3 or Al_2O_3 both Na and H ions determine the potential. Further variation of composition has no effect. The action of the glass electrode depends only upon its composition and is not (as has been suggested) connected with the water solubility or electrical resistance. The structure of the vitreous state was considered in relation to the linking of the migratable sodium ions in glass. G.R.S.

Calculating the coefficient of expansion of silicate glasses. P. GILARD AND L. DUBRUL. *Verre & Silicates Ind.*, **5** [7], 122–25; [8], 141–45 (1934).—After discussing various methods suggested for calculating the coefficient of expansion of glasses from their composition, parabolic formulas obtained from the examination of measurements made of 316 silicate glasses are developed. The coefficient of linear expansion between the ordinary temperature and 100 to 130° can be obtained from the relation $\alpha{\cdot}10 = \Sigma (ax + bx^2)$. For glasses containing lead and boron, these factors are not applicable when the alkali content becomes low (about 5%). There is no definite relation between the factors of expansion and the place of the elements in the periodic classification, except that these factors vary roughly in the inverse order of their valency. M.V.K.

Causes of the β-, γ-pigmentation of alkali, barium, and alkali-borate glasses. JOSEF HOFFMANN. *Z. anorg. allgem. Chem.*, **218** [2], 129–38 (1934).—Glasses with 5 to 10% BaO become gray on X-radiation; with 25 to 40% BaO they become violet. Radium radiation also changes the color of glasses. Such changes in color were studied in relation to constitution. In $Na_2O{\cdot}2SiO_2$ melts quenched from above 1400°C, adsorbed and free silica configurations become visible as black radiation colors. It is possible that forms higher in sodium than sodium monosilicate cause violet coloration. $Na_2B_4O_7$, however, does not cause the violet color change. The causes of color

change in barium glasses could not be definitely determined. L.T.B.

Correlation of viscosity measurements with flow of glass. (A) Development of platinum alloy-lined die: the die of unvarying diameter. H. K. RICHARDSON. *Jour. Amer. Ceram. Soc.*, **17** [8], 235–39 (1934). **(B) Flow of glass through tubular orifices.** *Ibid.*, pp. 239–44. **(C) Automatic control of temperature of small glass streams by radiation pyrometers.** H. K. RICHARDSON AND F. A. NEWCOMBE. *Ibid.*, pp. 244–48.

Decolorizing of glass. W. E. S. TURNER. *Chem. Trade Jour.*, **94** [2447], 274 (1934).—T. discusses the coloring effects of the ferrous and ferric oxides and reviews the work of Zsigmondy (*Ceram. Abs.*, **9** [1], 20 (1930)) on the light absorption of glasses containing iron, nickel, cobalt, manganese, neodymium, and didymium. According to Jaeckel (*ibid.*, **10** [2], 105 (1931)), the decolorizing effect of neodymium and nickel oxides is due to the additive color and the neutralizing action of the two oxides on the color produced by iron. Manganese, however, does not behave in the same way; it is thought that a colorless compound of manganese and iron oxide is formed in the glass. The best way to decolorize glass is to eliminate the necessity of decolorizing altogether by cutting down the iron content. In a case where careful control had been kept of every source of iron in making crystal glass, the need for decolorizing was eliminated for several months. M.V.K.

Determination of the transformation point of the same optical glasses in three different laboratories. E. BERGER, M. THOMAS, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **18** [69], 79–87 (1934).—The transformation temperature of seven optical glasses of different composition and physical properties have been determined at Jena, Berlin, and Sheffield, using the thermal expansion method at Jena and an electrical resistance method in different forms at Berlin and Sheffield. The results are all in such good agreement as to indicate, in general, that the transformation point, when the glass is heated at a rate of approximately 4°/min., can be determined with an error not exceeding ±5°.

Diffusion of potassium in glass. BELA V. LENGYEL. *Z. phys. Chem.*, **A167** [3], 295–311 (1934).—The diffusion of potassium into glass was studied over a range of temperatures extending to more than 400°C. The diffusion of the potassium ion follows the Frick law. Diffusion was determined by differences in weighing. The relation of diffusion to the sodium content of the glass is reported. On the basis of the results, a law of ion mobilities independent of concentrations is expressed. L.T.B.

Distribution of temperature during pot arching. W. MASKILL. *Jour. Soc. Glass Tech.*, **18** [69], 71–78 (1934).—Investigations have been made of the temperature distribution in and around a pot during the arching period. Three such investigations are recorded, the points for temperature measurement being at the shoulder, inside, and outside the base of the pot, respectively. Considerable differences in temperature have been found, which amount, in one case, to 170° between the first two positions. A gradient of 10°/in. across the pot bottom in each case was found. In two of the three tests reported there occurred frequent sudden fluctuations in temperature over the whole of the arching period.

Efficiency of heat-absorbing glasses. C. E. GOULD AND W. M. HAMPTON. *Glass Ind.*, **15** [6], 107–10 (1934).—Data expressed in terms of solar radiation are presented and it is concluded that it is not possible to represent the efficiency of a heat-absorbing glass by any single numerical value, but that if the best glass is one which has the highest light transmission for a given heat absorption, the efficiency of such a glass can be judged satisfactorily by the position of a point representing its light and heat transmissions on a diagram using light transmission and heat transmission as ordinate and abscissa. The data available show that iron oxide in the reduced form is the most efficient oxide for the production of heat-absorbing glasses of high light transmission. Further developments can proceed only along the lines of more suitable bases and better chemical reduction of the iron, unless a new and unexpected coloring material can be found. E.J.V.

Essentials of glass technology based on American practice. X. S. R. SCHOLES. *Ceram. Ind.*, **22** [7], 386–88 (1934).—Viscosity may be defined as the internal friction arising from the cohesion between the molecules of a liquid. The units for measuring viscosity are explained. The effect of viscosity on crystallization, on plaining or fining, and on strain in glass is discussed. The relation of viscosity to working processes is pointed out and it is shown that viscosity is distinct from plasticity. Methods for measuring viscosity are described. For Part IX see *Ceram. Abs.*, **13** [8], 203 (1934). E.J.V.

Form, design, and decoration of glass. H. LLEWELLYN SMITH AND JAMES H. HOGAN. Presented at meeting of Society of Glass Technology, London, May, 1934; *Pottery Gaz.*, **59** [685], 832–39 (1934). E.J.V.

Fused glass said to give better illumination. FAYETTE GLASS CO. *Ceram. Ind.*, **22** [7], 353 (1934).—Twinray glass is a composition of two sheets of glass fused in their molten state, one sheet of daylight glass and the other of whitish opal. Several types are produced. E.J.V.

Glass annealing. S. E. MONKHOUSE. *Elec. Rev.*, **114** [2949], 782 (1934).—M. discusses briefly the application and advantages of electricity in heating glass-annealing leers. The principal advantage over gas heating is a more exactly controlled temperature applied where most needed. This allows increased production with greatly reduced spoilage or damaged ware. Upkeep is low since refractories last much longer with electric heat than with gas or oil. Illustrated. J.L.G.

Influence of boric oxide on the rate of melting and on the thermal expansion and resistance to weathering of soda-lime-silica sheet glasses. VIOLET DIMBLEBY, MICHAEL PARKIN, ERIC SEDDON, W. E. S. TURNER, AND FRANCIS WINKS. *Jour. Soc. Glass Tech.*, **18** [69], 13–18 (1934).—The influence on the melting rate, thermal expansion, and resistance to water of the progressive addition of small amounts of boric oxide up to a maximum of 1.5% has been determined in reference to soda-lime (magnesia)-silica glasses of the type employed for sheet glass. Melting determinations on some fifty glasses show that the rate of melting is definitely accelerated. Based on the examination of twenty glasses it is found that the thermal expansion is, in general, slightly reduced and therefore improved. The improvement in resistance to water is either slight or inappreciable.

Mechanical batch feeding. ANON. *Glass Ind.*, **15** [6], 114–15 (1934).—The manual and mechanical methods of filling in the batch to the furnace are compared, and it is shown that the mechanical method will aid in producing better glass, better working conditions, more homogeneous glass, increased checker life, decreased fuel costs, and in many instances decreased labor costs. Illustrated. E.J.V.

Method for producing gold leaf inscriptions behind glass. FR. HTH. *Diamant*, **56** [11], 126 (1934).—A new patented, simple method for obtaining gold leaf inscriptions on glass plates, glass shields, etc., is described. M.V.K.

Minerals and mineral products used in the glass industry. I. L. SILLS. *Can. Mining Met. Bull.*, No. 267, pp. 365–87 (1934).—S. discusses briefly the sources, specifications, and mode of utilization in the industry of sand, soda ash, lime and magnesia, feldspar, calcined and hydrated alumina, cobalt oxide, selenium, white arsenic, sulfur, graphite, borax, fluorspar, cryolite, bone ash, bichromate of potash or soda, salt cake, niter cake, and barium compounds. The possibility of the use of nepheline syenite in place of feldspar and important potential sources of nepheline syenite in Ontario are pointed out. G.M.H.

Production of rock wool as a problem in glass technology. CHARLES F. FREYLING. Presented at Conference on Glass Problems, Urbana, Ill., June, 1934; abstracted in *Glass Ind.*, **15** [6], 119 (1934).—Rock wool consists of an aggregate of fine fibers, extremely fine glass rods, interspersed with small beads or "shot," actually minute pear-shaped glass beads. Rock wool was produced experimentally in kilogram samples by fusing woolrocks and synthetic mixtures of silica, alumina, lime, and magnesia with an induction furnace and pouring the fluid glass into a steam blast. The quality of the rock wool is determined by the average fiber diameter of the material, which is a function of the molecular ratio of acid to bases, alumina and silica being considered as acids. E.J.V.

Repairing objects of glass by fusing. A. KARVONEN. *Z. Instrumentenk.*, **54** [5], 159 (1934).—Cracks of considerable extension can be repaired by brushing them over with a thick solution of water-glass (sodium silicate) and carefully heating with the blowpipe. Loose, broken pieces can be attached again in the same manner. M.H.

Routine analysis of soda-lime-silica glasses. ANON. *Glass Ind.*, **15** [6], 118 (1934).—A brief outline, using standardized methods, of the adoption of unit methods for glass analysis, reducing the time required nearly half, is given. E.J.V.

Specific heats of some commercial glasses. C. W. PARMELEE AND A. E. BADGER. Presented at Conference on Glass Problems, Urbana, Ill., June, 1934; abstracted in *Glass Ind.*, **15** [6], 120 (1934).—Specific heat constants for soda-lime glasses, a lead glass, a borosilicate glass, and an opal glass were determined. The method used to determine specific heats is a modification of the so-called "dropping method," in which the glass sample in a platinum container is dropped from a furnace into a calorimeter. Mean specific heats of the glasses have been obtained up to 1050°C with this apparatus. Measurements extended from this upper temperature down to 800°C at intervals of 50°C. E.J.V.

Structural and decorative trends in glass. WALTER D. TEAGUE. *Amer. Architect*, **141** [2607], 40–43 (1932).—T. traces the use of glass in building from the first use of window glass to the present trend to make structures of glass and metal. The newer glass-brick and glass-wall materials are discussed. Illustrated. E.J.V.

Study of the series of glasses containing sodium oxide, boric oxide, and silica. E. J. GOODING AND W. E. S. TURNER. *Jour. Soc. Glass Tech.*, **18** [69], 32–66 (1934).—Nearly fifty glasses belonging to the three series Na_2O–B_2O_3, Na_2SiO_3–B_2O_3, and $NaBO_2$–SiO_2 have been melted in the pure condition, their general characteristics determined, and the annealing temperatures, densities, and thermal expansions systematically measured. In the majority of cases, maxima or minima occur on the physical property-composition curves. The general results have been correlated with other known data and attempts made, inconclusively, to establish a connection between these maxima or minima and the chemical constitution of the glass.

Summary of a course of study of glass. R. D. *Rev. belge ind. verrières, céram., émail.*, **4** [10], 229–31 (1933).—The chemical constitution of glass and formulas representing it are discussed. Tables showing the centesimal composition of pane glass, plate glass, and hollow glassware of different countries are given. R. D. AND L. F. *Verre & Silicates Ind.*, **5** [2], 30–31; [4], 69–70 (1934).—The preparation of the vitrifiable mixture is described. Tables of the principal elements entering into the glass composition, opacifiers, colorizers, and refining agents are given. The manufacture of pane glass is described. For previous abstract see *Ceram. Abs.*, **13** [1], 10 (1934). M.V.K.

Surface tension of molten glass by the Jaeger method. K. C. LYON AND C. W. PARMELEE. Presented at Conference on Glass Problems, Urbana, Ill., June, 1934; abstracted in *Glass Ind.*, **15** [6], 120 (1934).—The methods used in the principal investigations of surface tensions of glasses are described. The Jaeger, or maximum bubble pressure method, is described in detail, the limitations and sources of error being discussed. The average value for the surface tension of soda-boric oxide-silica glasses studied was 250 dynes/cm. at an average temperature of 1250°C. E.J.V.

Temperature dependence of dielectric constants of glasses and ceramic bodies. C. SCHUSTERIUS. Presented at meeting of Kaiser Wilhelm Institute for Silicate Studies; abstracted in *Sprechsaal*, **67** [5], 60 (1934); *Keram. Rund.*, **42** [4], 44 (1934).—The dielectric constants of glasses and ceramic bodies were determined in dependence on temperature. A difficulty appears in glassy masses because they become conducting at high temperatures which affects the vibration. The method of measuring and apparatus used are described. Normal soda-lime-silica glasses showed a rapid rise of the dielectric constant at 400°, and potash glasses with a higher softening point, correspondingly later. When the conductivity of the dielectric appearing at higher temperatures is compensated in its effect on the high frequency vibrating measuring-circle by a suitable resistance combination, a considerable check in the increase of the dielectric constant occurs with a further increasing temperature. The polarization of mole-

cules appearing with the first softening effects an accelerated increase in the dielectric constant up to the point where with further rising temperature the thermal motion of molecules slowly reduces the polarization. This effect was observed in this form in ceramic bodies containing feldspar. It is difficult to explain how the jags come about in the curves; it is possible that aggregates of molecules become dissolved and for this require definite temperatures. The measurements should have shown whether the course of the dielectric constants is even as it was assumed. According to the investigations, it is not the case; even in the rigid range, there is not a straight course. M.V.K.

Thermal expansion of some soda-lime-silica glasses. E. Seddon, W. E. S. Turner, and F. Winks. *Jour. Soc. Glass Tech.*, **18** [69], 5–12 (1934).—Thermal expansions from room temperature to the softening point have been determined for a series of pure soda-lime-silica glasses ranging in composition from 70 to 80% SiO_2, 2.7 to 14.4% CaO, and 10.5 to 22.7% Na_2O. The linear thermal expansion coefficients range from 658 to 1054 $\times 10^{-8}$, and the relationship between thermal expansion and composition is linear. The transformation and transition points were determined. Illustrated.

Unintentional flashed glasses. Frank W. Preston. *Jour. Soc. Glass Tech.*, **18** [69], 67–68 (1934).—Referring to "A Study of the stresses in flashed glasses" by W. M. Hampton (*Ceram. Abs.*, **13** [3], 57 (1934)), P. directs attention to the stresses which may be set up in wire glass.

Use of alumina in glassmaking. Robert F. Ferguson. Presented at Conference on Glass Problems, Urbana, Ill., June, 1934; *Ceram. Ind.*, **22** [7], 362–66 (1934).—The historical background leading up to the use of alumina in glass is traced. With the advent of machine operation, a glass was required with longer working range and freedom from devitrification. Additions of alumina as feldspar accomplished these purposes. As a stabilizing agent, alumina in conjunction with lime permits a higher soda content than would be otherwise permissible. Technical literature was reviewed and viewpoints of the various authors were unified to eliminate discrepancies. There is a general agreement to the effect that alumina in glass promotes resistance to thermal and mechanical shock and increases luster. Small amounts of alumina produce a glass of long working range, improved working properties, and stability against devitrification. Improved fusibility and lower annealing temperatures have also been noted. Weather resistance, in spite of a high soda content, is possible when alumina is present. E.J.V.

X-ray determination of the structure of glass. B. E. Warren. *Jour. Amer. Ceram. Soc.*, **17** [8], 249–54 (1934).

PATENTS

Apparatus for annealing glassware. P. L. Geer and W. A. Morton (Amco, Inc.). U. S. 1,966,292, July 10, 1934.

Apparatus for feeding glass. A. H. Stewart. U. S. 1,965,438, July 3, 1934.

Apparatus for polishing glass plates or strips. J. H. Griffin (Pilkington Brothers, Ltd.). U. S. 1,964,320, June 26, 1934.

Apparatus for scoring corrugated glass sheets. George Aurien (Mississippi Glass Co.). U. S. 1,965,065, July 3, 1934.

Device for marking lenses, etc. J. H. Pearson (Continental Optical Mfg. Co.). U. S. 1,965,721, July 10, 1934.

Glass envelopes containing alkali metal vapor. Corning Glass Works. Brit. 411,029, June 6, 1934.

Glassmaking machines. United Glass Bottle Manufacturers, Ltd., T. C. Moorshead, and E. P. Dorman. Brit. 412,423, July 4, 1934.

Glass-to-metal thermal joint. M. E. Nordberg (Corning Glass Works). U. S. 1,964,329, June 26, 1934.

Glass rolling means. Yvon Brancart. U. S. 1,963,486, June 19, 1934.

Laminated glass. W. L. Monro. U. S. 1,963,798, June 19, 1934. G. B. Watkins (Libbey-Owens-Ford Glass Co.). U. S. 1,963,601, June 19, 1934.

Leer, annealing furnace, etc. T. C. Moorshead and F. A. Hurlbut (United Glass Bottle Manufacturers, Ltd.). U. S. 1,965,350, July 3, 1934.

Leers with roller beds. Pilkington Bros., Ltd., and F. B. Waldron. Brit. 411,528, June 20, 1934.

Manufacture of glass. Degea A.-G. Auerges. Brit. 412,110, June 27, 1934.

Means for molding wires in glass. C. G. Eden and C. J. Smithells (M-O Valve Co., Ltd.). U. S. 1,965,408, July 3, 1934.

Metal vapor lamp. H. P. Hood (Corning Glass Works). U. S. 1,964,321, June 26, 1934.

Method and apparatus for cooling glass. Corning Glass Works. Brit. 411,072, June 6, 1934.

Method and apparatus for cooling glass articles. Corning Glass Works. Brit. 411,075, June 6, 1934.

Method and apparatus for supplying molten glass. A. J. Smith (Hartford-Empire Co.). U. S. 1,963,763, June 19, 1934.

Method of conveying and rotating cylindrical glass. Naamlooze Vennootschap Mij. tot Beheer en Exploitatie van Octrooien. Brit. 411,030, June 6, 1934.

Method of cutting laminated glass. E. W. McConnell, Jr. (American Window Glass Co.). U. S. 1,966,353, July 10, 1934.

Method of joining different kinds of glasses. British Thomson-Houston Co., Ltd. Brit. 411,221, June 13, 1934.

Method of making vitreous materials. G. H. McIntyre and R. W. Stuart (Ferro Enamel Corp.). U. S. 1,963,910, June 19, 1934. In making glass, etc., by fusion of raw materials, the steps comprise progressively spreading a thin layer of the raw materials on a vat surface exposed to heat of a temperature to reduce the raw material to a molten condition, and collecting the resultant melt.

Ornamental glassware. A. H. Stewart (Phoenix Glass Co.). U. S. 1,963,156, June 19, 1934.

Pressing apparatus. J. L. Drake (Libbey-Owens-Ford Glass Co.). U. S. 1,965,113 and 1,965,114, July 3, 1934.

Safety glass. R. W. Wampler (Libbey-Owens-Ford Glass Co.). U. S. 1,963,569, June 19, 1934. G. B. Watkins (Libbey-Owens-Ford Glass Co.). U. S. 1,963,602, June 19, 1934.

Signaling means. S. L. Lebby (Corning Glass Works). U. S. 1,964,325, June 26, 1934.

Stopper polishing machine. N. R. Beck (Carr-Lowrey Glass Co.). U. S. 1,963,459, June 19, 1934.

Vitreous composition. H. G. GRIMM AND PAUL HUPPERT (I. G. Farbenind. A.-G.). U. S. 1,964,629, June 26, 1934. A vitreous composition consists of a fused mixture comprising an oxidic component and a vitrifying component containing equimolecular proportions of Al_2O_3 and P_2O_5 in a total amount of from 10 to 100% by weight of the vitrifying component.

Structural Clay Products

Brick construction without a trowel. ANON. *Brick Clay Rec.*, **84** [7], 235 (1934).—Estimated costs for the farmhouse of fabricated reinforced brick panels answer the demand for low cost housing. Building time is saved. Illustrated. E.J.V.

Clayworking in the East. III. W. H. BATES. Presented at meeting of Mining and Geological Institute of India, Dhanbad, July, 1933; abstracted in *Brit. Clayworker*, **43** [506], 90–91 (1934).—A discussion of the processes involved in the manufacture of sanitary pipe, salt-glazed ware, and red vitreous ware is given. For Parts I–II see *Ceram. Abs.*, **13** [8], 226 (1934). R.A.H.

Outline of work of reinforced brick masonry research board. F. E. RICHART. *Bull. Amer. Ceram. Soc.*, **13** [7], 179–80 (1934).

Permeability to air and water of building brick. E. O. MILLS. *Trans. Ceram. Soc.* [Eng.], **33** [5], 200–12 (1934).—A study of the permeability to air and to water of a number of common building brick was made using a modification of the apparatus of Clews and Green for the purpose of obtaining information on pore size and texture. The use of too high an air pressure was found to result in turbulent flow. The logarithm of the velocity of the water was plotted against the logarithm of the time as an indication of the uniformity of texture. R.H.H.P., JR.

Possibilities in reinforced brickwork. L. B. LENT. *Amer. Architect*, **141** [2604], 26–27 (1932).—L. points out that reinforced brick masonry is designed like reinforced concrete, is as easy to construct as ordinary brickwork, needs no forms or supports for vertical construction, and requires only simple centering for floor slabs or beams. Illustrated. E.J.V.

Reduce sewer-pipe breakage with chart. JOSEPH E. CICOTTE. *Brick Clay Rec.*, **84** [7], 246 (1934).—A chart developed to show laborers how to load sewer pipe of all sizes in cars to prevent breakage in transit is presented and discussed. E.J.V.

BOOK

Bonding of Brickwork. WILLIAM FROST. Cambridge University Press, London; Macmillan Co., New York. Reviewed in *Brick Clay Rec.*, **84** [7], 244 (1934).—Over 500 examples of bonding, all illustrated, are presented. They embrace the principles of setting out bonds for a great variety of conditions and different classes of work. E.J.V.

PATENT

Cellular clay body and method of producing. G. A. BOLE. Brit. 411,534, June 20, 1934.

Refractories

Corundum crucibles for the production of steel single crystals. V. POPOVA. *Metallurg.*, No. 2, pp. 58–60 (1933).—Small crucibles with a composition of Al_2O_3 79, SiO_2 17, and Fe_2O_3 3% were prepared by mixing crushed corundum with fire clay and firing at 1300 to 1400°. The crucibles withstood a temperature of 1900° without softening or reacting chemically with the steel charge. (*C.A.*)

High-frequency furnace linings and the results of the investigation of several lining failures. J. E. PRIESTLEY AND W. J. REES. *Trans. Ceram. Soc.* [Eng.], **33** [5], 177–99 (1934).—Two important types of linings, the rammed dry granular form and the unfired ring brick lining, employed in high-frequency melting furnaces are described in detail. The common causes of lining failure such as incorrect ramming, grading, steel penetration, corrosion and erosion of metal, slag-line corrosion, and top weakness are discussed. The mineralogical constitution of a magnesite lining from a steel furnace has been studied and a number of photomicrographs is presented. R.H.H.P., JR.

Insulating firebrick applications in steel-heating furnaces. M. J. TERMAN. *Iron & Steel Eng.*, **11** [6], 218–23 (1934).—As insulating fire brick, in comparison with fireclay brick, lack the necessary properties to withstand constant mechanical abrasion, heavy superimposed loads, slagging conditions, and various types of mechanical abuse, it is necessary to provide adequate protection for areas where these conditions are encountered. By using insulating brick instead of fireclay brick, the time saved in heating a furnace to operating temperature is a valuable item, depending on size and type of furnace, temperature limitations on rate of heating stock, burner capacity, and temperature control. The overall fuel savings for an insulating firebrick-lined furnace, as compared with a furnace lined with fireclay brick or a combination of fireclay brick backed up with insulation, are dependent on the length of cycle, duration of shutdown, and operating temperatures. Furnaces lined with insulating fire brick have a more even distribution of temperature throughout and are sensitive to temperature control because of low thermal capacity. Insulating fire brick also decrease the space requirements of a new furnace. Actual installations are described and data thereon are presented. Illustrated. See also *Ceram. Abs.*, **13** [6], 151 (1934). E.J.V.

Magnesia refractories in basic open-hearth steel furnaces. OLAF ANDERSEN. *Jour. Amer. Ceram. Soc.*, **17** [8], 221–35 (1934). Illustrated.

Permeability of refractory materials to gases. IV. Influence of firing process on the permeability to air of fireclay materials. F. H. CLEWS AND A. T. GREEN. Presented at meeting of English Ceramic Society at Llan-

dudno, May, 1934; abstracted in *Colliery Guard.*, **148** [3830], 990 (1934); for Part III see *Ceram. Abs.*, **13** [8], 211–12 (1934). E.J.V.

Production of aluminum by the aluminum-sulfide process. FREITAG. *Werkstoffe & Korrosion*, **9** [5], 18 (1934).—A new process of producing Al was developed to make Germany independent of bauxite which has to be imported. It consists in fusing aluminum sulfide instead of bauxite and employing rock salt as flux. Al sulfide is made in the electric furnace of ordinary clay by the addition of carbon; it contains much Fe and Si and is treated in molten state with pyrites whereby Al sulfide is formed. This is disintegrated by d.-c. electrolysis into S and Al; the disintegration voltage is 1 volt lower than in the bauxite process which is of great practical importance. Present experiments seem to be promising. M.H.

Refractories Division Research Committee 1933 Progress Report. DONALD W. ROSS. *Bull. Amer. Ceram. Soc.*, **13** [7], 188–89 (1934).

Spalling of refractories. ANON. *Blast Fur. Steel Plant*, **22** [6], 356 (1934).—Two causes of the spalling of furnace refractory brick are recognized, one resulting from thermal changes and associated physical changes in the material and the other due to mechanical stresses such as pinching, which occurs particularly in sprung arches. Physical spalling may be caused by a very steep temperature gradient through the refractory or by rapid temperature changes. Mechanical spalling results from localized stresses due to expansion of the mass and is liable to occur in arches through the reversible thermal expansions causing the arch to rise and alter its curvature. E.J.V.

BOOK REVIEW

First Report of the Commission for Testing Refractory Materials. Inst. for Material Testing, 's-Gravenhage, *Report*, No. 6, May, 1934. 76 pp. Price 1.0 Fl. The report contains a review of the quantities measured and testing methods so far in use, specifications and rules for testing, a review and comparison of specifications in foreign countries (Germany, France, U.S.A., England) with respect to requirements for refractory materials, and a résumé of the whole and propositions for standards to be accepted in Holland. M. HARTENHEIM

PATENTS

Checkerwork. E. A. BROWN, JR., AND M. M. MARKS. U. S. 1,963,291, June 19, 1934.

Checkerwork brick structure. K. H. MOLL AND PAUL STICKEL. U. S. 1,964,267, June 26, 1934.

Fire brick. C. W. THORNBOROUGH (A. E. Staley Mfg. Co.). U. S. 1,963,181, June 19, 1934.

Method of surfacing refractory articles and the product thereof. C. L. NORTON (Babcock & Wilcox Co.). U. S. 1,964,743, July 3, 1934.

Refractory brick. DIDIER-WERKE A.-G. Ger. 590,207, Dec. 28, 1933; addition to 487,110. Binding clay in the form of a slip is mixed with less plastic clay or with clay or bauxite which has been partly dehydrated by heating at a temperature up to 600°. The mixture is then molded and fired. (*C.A.*)

Refractory synthetic magnesia product and process of making. W. J. MCCAUGHEY AND H. C. LEE (Non-Metallic Minerals, Inc.). U. S. 1,965,605, July 10, 1934. As a new article of manufacture a calcined refractory magnesia product comprises magnesia, less than 3% of silica, about 4.7% to about 9.7% of a mixture of iron oxide and alumina, and lime, the amount of the lime being substantially equal to twice the amount of the silica, plus additional lime equal to about 40% to about 70% of the mixture of iron oxide and alumina.

Terra Cotta

Origin and manufacture of California's clay roofing tile. ROSS C. PLANK. *Bull. Amer. Ceram. Soc.*, **13** [7], 180–83 (1934).

Patterns for special shapes. L. R. WHITAKER. *Brick Clay Rec.*, **84** [7], 238–39 (1934).—Simple methods by which plant operators can develop odd-shaped brick from architect's plans are outlined. Illustrated. E.J.V.

PATENT

Chimney pots, etc. W. F. LOUDON. Brit. 412,360, July 4, 1934.

White Wares

Japanese pottery imports into Britain. ANON. *Times Eng. Supp.*, **34**, 136 (1934).—The substantial increase of Japanese imports compared with a considerable reduction from other countries has been the subject of representation from the National Council of the Pottery Industry to the British Government. H.H.S.

Pottery manufacturing problems. ANON. *Pottery Gaz.*, **59** [685], 843–47 (1934).—A discussion of the following problems is presented: blending of plaster, cast handles, cast dishes, glaze loss by dunting, white spots in pink glazes, green glaze difficulties, blistered glaze, and difference in color of the body. E.J.V.

Preparing slips and glazes for best results. LAWRENCE H. BROWN. *Ceram. Ind.*, **22** [7], 376–78 (1934).—Each type of slip or glaze has its own set of preparation and grinding specifications, a deviation from which results in something less than an A-1 prepared slip or glaze. Suggestions for handling a batch of glaze to obtain the maximum benefit from the grinding equipment are presented. The effect of grinding of a glaze on proper drying or splitting of ware walls is discussed. Observations on the effect of varying amounts of heat treatment on commonly used stains and the resulting effect, after grinding, on the dipping properties of the glazes containing them are presented. E.J.V.

BOOK REVIEW

Technology of Porcelain and Faience Manufacture. YA. I. SHERMAN. Ukrainian State Publishing House of Light

Industry, Kharkov, 1934. 308 pp., 175 figs. Price 12 R. This book is the largest in U.S.S.R. entirely devoted to whiteware manufacture. It deals with the subject under the following headings, which give a summary of its contents: (1) Basic raw materials used in whiteware manufacture (more exactly in fine ceramics, corresponding to the German *Feinkeramik*); (2) Calculations of ceramic masses; (3) Preparation of ceramic masses. In this section is given a description of new methods of kaolin elutriation and enrichment, continuous ball mill for wet grinding, vibration seives, etc.; (4) Drying ceramic ware. After a short discussion on physical foundations of drying, the modern periodic and continuous driers are described. Two calculations for a periodic drier for household faience and a mechanical drier of the conveyer type for faience plates are outlined. (5) Glazes are considered as glasses with special properties. Calculations and defects of glazes are dealt with. (6) Firing ceramic ware. After a description of modern periodic and continuous ceramic furnaces, special attention is given to tunnel kilns of Dressler, Harrop, Kerabedarf, Richardson, Lengensdorf, Kidoux, Russel, Otto, Ferguson, etc. Small, ring, and electric tunnel kilns are also discussed. Tables are given characterizing the dimensions and the basic data of the work of industrial furnaces. Table 49 gives data for six round furnaces, the work of which has been examined by S. Table 49*a* and 49*b*, pp. 134–35, contain data on the work of 28 American furnaces (draft, purpose: bisque, glost, one-fire, etc.; fuel, P.C.E., hours on fire, ware weight in per cent of total setting, diameter of the furnace, gross floor area, gross volume, cross-sectional area of floor flue, number of fire boxes, ratio of height to diameter, kiln volume per fire box, grate area in per cent of floor area, etc.). The table in Appendix 4, p. 298, gives data on the work of 95 German furnaces. All these tables may serve for calculations of ceramic furnaces. (7) Effective heat by firing ceramic ware. Examples of calculations are given for an artificial drier, a round furnace, etc. The last five chapters are devoted to the manufacture of separate types of whiteware as follows: faience, sanitary technical faience, porcelain, electric porcelain, ceramic products of steatite (spark plugs, etc.). Notwithstanding a few misprints and a somewhat protocol character of description this book should be regarded as a useful contribution in the field of fine ceramics. S. I. PERKAL

PATENTS

Flush receptacle fitting for underfloor conduit systems. L. A. SHARP (National Electric Products Corp.). U. S. 1,965,087, July 3, 1934.

Spark plug. MARTIN O'MARRA. U. S. 1,963,801, June 19, 1934.

Water-closet bowl. G. P. GAVIN. U. S. 1,964,876, July 3, 1934.

Equipment and Apparatus

Automatic brick machine is continuous production type. W. E. DUNN MFG. CO. *Pit & Quarry*, **26** [12], 47 (1934).—A new automatic, straight-line, continuous production type of brick machine has been developed in which the pallet boxes pass under an open-bottom hopper where the material is measured and then passed under a graduated packer-head from where the finished brick are delivered by an endless carrier to an off-bearer. A void in the under mortar bed reduces the weight about a pound below that of ordinary brick and is said to require 20% less material. Illustrated. E.J.V.

Calculating loss of pressure in pipe lines and conduits. W. BARTH. *Arch. Eisenhüttenwesen*, **7**, 599–605 (1934).—Calculations of pressure losses have been carried out using the same formula for gases and liquids. Factors regarding the conditions of the walls and type of flow have been determined. These may be taken from a diagram which is based on Reynold's factor. Computation tables are presented together with samples of such calculations. The theory of flow in pipe lines and conduits is discussed. W.M.C.

Chromium plating of printing plates. J. G. ROBERTS. *Trans. Ceram. Soc.* [Eng.], **33** [5], 213–14 (1934).—The useful life of steel engraved pottery printing plates has been increased indefinitely by chromium plating. R.F. H.P., JR.

Color sensitivity of the eye against illumination and hue. Development of a sensitive color pyrometer. G. HAASE. *Ann. Physik*, **20** [1], 75–105 (1934).—Principles of construction of a sensitive color pyrometer with comparison field are outlined. The color sensitivity of the human eye has been investigated for this work. It has been found that the maximum sensitivity will show different values with an increasing brightness. The working range of the new pyrometer is around 570 mμ, the comparison field containing 40% white color. The sensitivity of the instrument amounts to 2.5° at 1500°K. W.M.C.

Electric heating in laboratory apparatus of the chemical industries. LUDWIG MUELLER. *Elektrowärme*, **4** [5], 105–10 (1934).—Apparatus and processes for drying, heating solid materials in closed chambers, heating liquids in heating apparatus, annealing and firing in furnaces, bacteriological processes, etc., are described. Special importance is laid on constancy of temperature and temperature regulators. A molybdenum tubular furnace for 1500°C and a Tammann induction crucible furnace for 3000°C are mentioned particularly. M.H.

Electrical temperature-measuring instruments. FRITZ BECK. *Metallwirtschaft*, **12** [39], 561–62 (1933).—An exhaustive description of principles and construction of electric resistance thermometers, thermoelectric pyrometers (thermocouples), and radiation pyrometers is given. Resistance thermometers can be used only up to 600°C and require current supply. Thermocouples are now used in the following combinations:

Element	Range up to (°C)	Full Scale e.m.f. (millvolt)
Copper-constantan	500	27
Silver-constantan	600	33
Iron-constantan	800	45
Chrome-nickel-constantan	900	60
Nickel-nickel-chrome	1100	37
Platinum substitute (special alloy)	900	8.4
Platinum-platinrhodium	1600	17
Rhodium-platinrhenium	1800	20
Rhodium-rhodium-rhenium	1900	7.2
Iridium-iridium-rhodium	2000	10.85

A list of protective tubing for thermocouples for different temperature ranges is given. The temperature range for pyrometers can be extended to 3000°C by using a red filter before the ocular lens. Pyrometers for both total and part radiation have the advantage that they are not exposed to the temperatures to be measured; total radiation pyrometers have practically no time lag in their indications but require comparatively large radiating surfaces, while partial radiation instruments measure only light of certain wave-length and are used mostly for control purposes. M.H.

Floating pumps. HAWIG ELEKTROTECHNISCHE FABRIK. *Eng. Progress*, **15** [4], 76 (1934).—A floating centrifugal pump is described which contains the driving motor in a water-tight floating case integral with the pumping mechanism. The pumps are light in weight for ready transportation. Pumps are designed for capacities up to 220 gal./min. at pressures up to 85 lb./sq. in. The floating pump is especially valuable where liquids have to be raised longer distances than centrifugal pumps are usually good for when they have to be placed some distance above the liquid to be raised. Illustrated. J.L.G.

Freezing point of platinum. F. HOFFMANN AND C. TINGWALDT. *Physik. Z.*, **35** [11], 434–36 (1934).—Experiments were carried out in a high-frequency furnace using a thoria crucible containing molten platinum. A thoria tube partly filled with thoria powder is immersed in the melt. The "black" radiation emerging from the tube is measured. The freezing point was found to be 1774.2°C. W.M.C.

Furnaces for elevated temperature tests. H. MONTGOMERY AND J. W. BOLTON. *Metals & Alloys*, **5** [6], 127–30 (1934).—A type of furnace used in elevated temperature creep and short-time testing offering considerable flexibility in localized temperature control is described. Temperatures within and without the bar over the gage length do not vary more than 2°F. R.H.H.P., JR.

Gravity balance. KENNETH HARTLEY. *Eng. Mining Jour.*, **135** [5], 201–202 (1934).—A gravity balance designed for use in geophysical prospecting is described by the aid of a diagram. It detects the presence of large masses of material of different densities by measuring the change in the force of gravity at different points along the surface above them. Measuring the stretch of a calibrated spring under a known weight by optical methods gives an accuracy of one ten-thousandth of 1%. J.L.G.

Impact losses and friction factors for pipe lines and conduits. H. EULER. *Arch. Eisenhüttenwesen*, **7**, 606–14 (1934).—New data regarding the losses are presented in a form for practical use. Friction factors for smooth and rough pipes of different shape are given, as well as factors for valves, slide valves, faucets, etc. All losses depend largely on Reynold's factor and the ratios of speed and amount of material flowing in the unit of time. This paper is supplementary to that by Barth, "Calculating loss of pressure," p. 238. W.M.C.

Impregnation of filter cloth. M. O. KHARMADARYAN AND L. I. SIVOPLYAS. *Ukrain. Chem. Jour.*, **8** [1], 125–26 (1933).—Before impregnation, the cloth which is used in filter-pressing whiteware masses is immersed in a soda solution prepared from 1 kg. soda ash dissolved in 25 liters of water. The solution is slowly brought to boiling and boiled 1½ hr. The cloth is then immersed in a vessel with a second solution prepared as follows: pure copper carbonate is dissolved to saturation in 1 liter of 25% ammonia. To this solution is added 2 to 3 liters of water and the mixture is filtrated after a good mixing. The cloth remains in this solution 2 hr. and then is taken out and dried at 60°C. It is claimed that the service life of the impregnated cloth is increased. S.I.P.

Improved drying practice. ERNEST W. KNAPP. *Brick Clay Rec.*, **84** [7], 242–44 (1934).—Instructions are given for constructing a test drier which will eliminate guesswork in drying practice and save money in actual operation. Illustrated. E.J.V.

Induction heating with normal low frequency in chemical industries. O. NEISS. *Siemens-Z.*, **14** [5], 175–78 (1934).—Nonconductive materials can be economically heated electrically in the temperature range 180 to 1000°C by ordinary low-frequency supply by indirect methods, *i.e.*, the container for materials is of magnetic or electrically conducting material and heated inductively; the containers can be of any shape suitable for the material to be heated. Examples of heating arrangements for metallurgical, chemical, and ceramic purposes are described. M.H.

Metallographic method for determining furnace temperature uniformity. E. H. DIX, JR., AND A. C. HEATH, JR. *Metals & Alloys*, **5** [1], 10 (1934).—The temperature uniformity in a small electric muffle-type furnace has been investigated at temperatures near the eutectic melting point of an aluminum-silicon alloy by quenching samples and examining them microscopically for evidence of partial melting. R.H.H.P., JR.

Mounting small metallographic specimens and metal powders in bakelite. H. M. SCHEICHER AND J. L. EVERHART. *Metals & Alloys*, **5** [3], 59–60 (1934).—A method of mounting small specimens for metallographic examination in bakelite resinoid is described in detail. Metal powders may be examined for particle size by mounting them in bakelite varnish. R.H.H.P., JR.

Portable gas calorimeter. HAYS CORP. *Glass Ind.*, **15** [6], 126 (1934).—A portable unit for measuring the heating value of various industrial gases is described in detail. It may also be used to ascertain the amount of combustibles unburned in whole gases, for safeguarding sewage systems by testing the explosive properties of sewage gases, for determining explosive limits of gases, and for adjusting gas burners for correct air-gas mixtures, etc. Illustrated. E.J.V.

Progress report on the determination of absolute viscosity. J. R. COE, JR. *Physics*, **4** [8], 274–78 (1933).—An apparatus designed for the precise measurement of absolute viscosity is described. The liquid studied is caused to flow from one reservoir through a capillary tube into a second reservoir, the pressure difference between the two being measured with a differential manometer. Various rates of flow are caused by injection of mercury into the upstream reservoir from a cylinder by means of a uniform piston driven at constant speed by a synchronous motor through a gear train. A number of interchangeable capillaries of different bore diameters and lengths can be employed. The displacement apparatus and the viscometer are thermostated in baths designed for precise temperature control. A machine designed and built to lap the bores of capillaries into right circular cylinders is described.

Sampling mine air for dust. ARNOLD S. BLACK. *Eng. Mining Jour.*, **135** [5], 218–19 (1934).—Apparatus for both gravimetric and volumetric sampling is illustrated and described. Gravimetric results are obtained in milligrams of dust per cu. m. and volumetric results in particles of dust per cu. cm. Illustrated. J.L.G.

Vacuum furnaces in metallurgy. N. A. ZIEGLER. *Metals & Alloys*, **5** [1], 5–9 (1934).—Several types of resistance and induction vacuum furnaces in use in laboratories are described in detail with a view toward their future adaptation in the commercial field. R.H.H.P., JR.

BULLETIN

Dry cells and their application to mining. A. B. HOOKER AND E. J. COGGESHALL. *Bur. Mines Rept. of Invest.*, No. 3231, 8 pp. Free. The report discusses the application of dry cells in electric shot firing, auxiliary lighting, signaling, and testing. R.A.H.

PATENTS

Apparatus for cutting an extruded slab of clay into clods and for dealing with such clods in connection with the manufacture of brick, etc. H. H. BAILEY AND J. JACKSON. Brit. 411,572, June 20, 1934.

Apparatus and method for freeing clay, etc., from stones and other foreign bodies. H. C. RAFETTO. U. S. 1,966,312, July 10, 1934.

Apparatus for molding pierced and indented dry brick. F. A. ARMSTRONG. U. S. 1,965,758, July 10, 1934.

Apparatus for roasting mineral-bearing particles. B. A. STIMMEL, K. D. MCBEAN, AND GRAHAM CRUICKSHANK (Consolidated Mining & Smelting Co. of Canada, Ltd.). U. S. 1,963,282, June 19, 1934.

Apparatus for sintering and fusing finely divided material. A. B. HASWELL AND F. G. CUTLER. U. S. 1,964,915, July 3, 1934.

Continuous rotary filters. C. S. ROBISON. Brit. 411,900, June 27, 1934.

Driving gear of reciprocating mechanism such as jiggers, shaking conveyers, etc. KARL STROEDTER (Gebr. Eickhoff Maschinenfabrik und Eisengiesserei). U. S. 1,966,319, July 10, 1934.

Filter-cake thickness control. A. J. FISCHER (Dorr Co., Inc.). U. S. 1,963,616, June 19, 1934.

Hydraulic presses. M. M. EATON. Brit. 411,413, June 13, 1934.

Multiplex rotary filter. F. W. BECRAFT (Dorr Co., Inc.). U. S. 1,963,610, June 19, 1934.

Off-bearing machine. G. E. LUCE AND R. G. COX (Lancaster Iron Works, Inc.). U. S. 1,965,745, July 10, 1934.

Sandblasting or sandblowing means for use in the manufacture of earthenware tile. W. H. WRIGHT. Brit. 412,330, July 4, 1934.

Tunnel driers for brick and tile drying. A. E. BROWN. Brit. 411,838, June 27, 1934.

Kilns, Furnaces, Fuels, and Combustion

Calorimetric determination of the heats of combustion of ethane, propane, normal butane, and normal pentane. FREDERICK D. ROSSINI. *Bur. Stand. Jour. Research*, **12** [6], 735–50 (1934); R.P. 686.—The present investigation on the calorimetric determination of the heats of combustion of ethane, propane, normal butane, and normal pentane was undertaken because of the dearth of information concerning these thermochemical constants for which there is pressing need in industry and in the sciences. The data of this investigation give, for the heats involved in the combustion in oxygen at a temperature of 25°C and a constant pressure of 1 atmosphere of gaseous ethane, gaseous propane, gaseous butane, and gaseous pentane, respectively, to form gaseous carbon dioxide and liquid water, the following values in international kilojoules per mole: ethane 1559.57 ± 0.44, propane 2219.57 ± 0.51, normal butane 2877.88 ± 0.63, normal pentane 3536.00 ± 0.88. The hitherto "best" values compare with the above values as follows: ethane −1.23, propane −0.87, normal butane, no existing data, normal pentane −0.86. These differences are from 30 to 50 times the estimated uncertainties in the values from the present investigation. R.A.H.

Circular tunnel kiln provides controlled firing. ANON. *Ceram. Ind.*, **22** [7], 368–69 (1934).—The new kiln at the Salem China Co. firing dinnerware under regulated conditions has a "zone-controlled" firing section whereby each firing unit is under separate control; an overlapping effect in heat application is produced. This combination of "controlled zones" in the firing section has the effectiveness of grouped firing units with the flexibility of individually controlled units. A detailed description of the kiln construction is presented. A new type pusher helps provide controlled operation. Illustrated. E.J.V.

Coal requirements of various ceramic ware in firing. ELLIS LOVEJOY. *Bull. Amer. Ceram. Soc.*, **13** [7], 176–78 (1934).

Correcting firing problems that arise due to negligence. ANON. *Brick Clay Rec.*, **84** [7], 240–41 (1934).—On checking causes for loss in a brick plant it was found that brick were being set carelessly, the kilns were not fired in rotation, equipment was in poor condition, the draft was sluggish, the brick were not properly dried so that prolonged water-smoking was necessary, and uneven tracks on the transfer car and in the drier caused cracking. On correcting these conditions the loss was reduced considerably. E.J.V.

Diffusion combustion. H. M. HEYN. *Fuels & Fur.*, **11** [3], 111–12 (1933).—Diffusion combustion in terms of a forge shop might be defined as the process of efficiently burning gas in such a manner as to produce uniformly heated steel with practically no scale. With this type of combustion a smaller furnace can be used to turn out a given output. A pusher-type diffusion forge furnace installation is described in detail with operating data. Illustrated. E.J.V.

Diffusion combustion—what is it? W. M. HEPBURN AND R. C. PURDY. *Bull. Amer. Ceram. Soc.*, **13** [7], 184–86 (1934).

Electric furnaces. E. MORGAN. *Elec. Rev.*, **114** [2949], 792 (1934).—Electric-arc and high-frequency furnaces used in the steel industry are briefly considered. Illustrated. J.L.G.

Equal thermal history is essential to secure uniform and definite properties of ceramic ware. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **13** [7], 175 (1934).

Evolution of the mineral coals. I. J. VOLNEY LEWIS. *Econ. Geol.*, **29** [1], 1–38 (1934).—Under composition of the coal series, L. considers swamp forest débris, the humic complex, essential elements, and atomic ratios with gravimetric and atomic diagrams. Under transformations he considers the wasting processes, volatile products, stages of decay, rotting in air, decay under water, subterranean changes, graphic examination of chemical changes, and calculation of losses. Illustrated. **II.** *Ibid.*, **29** [2], 157–202 (1934).—The following conversions are considered: vegetable débris into peat, peat into lignite, lignite into sub-bituminous coal, sub-bituminous into bituminous, bituminous into superbituminous, superbituminous into subanthracite, subanthracite into anthracite, anthracite into metanthracite, metanthracite into subgraphite, and subgraphite into graphite. Accumulation and condensation are then considered. An extensive bibliography is appended. Illustrated. J.L.G.

Fuel saving in the ceramic industry. FELIX SINGER. Presented at meeting of English Ceramic Society, Stoke-on-Trent; *Pottery Gaz.*, **59** [685], 840–42 (1934). E.J.V.

Furnace calculations. JOHN W. ROMIG. *Glass Ind.*, **15** [6], 111–13 (1934).—To obtain information on furnace installations regarding the volume of air admitted for combustion and the volume of products of combustion, actual per cents of excess air, etc., analyses of producer gas, waste gas, coal analysis, and the amount of steam blown to the producer are necessary for the calculations. Detailed examples of the actual calculations are given. E.J.V.

Investigation of silicon carbide-containing heating elements in open air. L. NAWO AND WILHELM MEYER. *Elektrowärme*, **4** [6], 140–41 (1934).—Silit, Globar, and quartzilite were tested in the range 800 to 1400°C; they were practically identical in open air and in horizontal position. Heat conductivity is 20 k. cal./m./hr./°C from 1000 to 1400°. M.H.

Kiln for economical firing. J. C. BOOTH. *Brick Clay Rec.*, **84** [7], 239 (1934).—A new design of tandem-type downdraft kiln that has proved economical to operate has two parallel firing chambers separated by flues which carry the exhaust heat away through short stacks. E.J.V.

Natural cooling and heat recovery. K. MERTENS. *Elektrowärme*, **4** [6], 132–36 (1934).—Several examples are given to show that in spite of the high cost of electric energy the economy of electric furnaces for metallurgical and ceramic purposes can be improved largely by recuperation of heat so that they can easily compete with other fuel-fired furnaces. M.H.

Rhodium wire for laboratory furnaces. I. WESTERMANN. *Metallwirtschaft*, **11** [11], 152–53 (1932).—Construction of a tubular furnace with Rh wire as heating element is described which can be used safely for 1700°C (3100°F) and for higher temperatures for a limited time. M.H.

Sealing periodic kiln crowns reduces losses in firing. R. T. GILES. *Brick Clay Rec.*, **84** [7], 254–56 (1934); *Metals & Alloys*, **5** [2], 28–30 (1934).—A successful and economical method for sealing kiln crowns against the infiltration of water and air has been developed by using an alumina hydraulic cement mixed with some type of fired clay aggregate or by using one of the dry, trade-marked castable refractories on the market. The aggregate should be of the same general type as the top of the crown and mixed in proportions of $2^1/_2$ parts to 1 part of cement. The mortar should be applied in a thickness of $^3/_4$ to 1 in. By the use of a lightweight, highly porous, weather-resistant aggregate such as Haydite, a combination seal and insulating coat is produced. This should be applied in a 4- to 6-in. coat. Illustrated. E.J.V.

Volatilization of silica and copper in steam. J. GILLIS. *Natuurwetensch. Tijds.*, **15**, 153 (1933).—Amorphous silica is more volatile in steam than quartz. This is shown by the quantities of willemite formed on the surface of ZnO placed at a distance of 5 cm. from the silica in an atmosphere of steam at 300 atmospheres pressure. Copper cylinders weighing 20 g. lost about 50 mg. in steam at 300 atmospheres after 3 days, but cassiterite and rutile showed no change. (*T.C.S.E.*)

PATENTS

Electric furnaces. ELECTRIC RESISTANCE FURNACE CO., LTD., AND F. G. CONNOR. Brit. 411,162, June 13, 1934.

Process of manufacturing producer gas of high calorific value. KARL KOLLER AND ZSIGMOND GÁLOCSY. U. S. 1,964,207, June 26, 1934. A process of manufacturing producer gas of high calorific value in a continuous unidirectional flow is carried out in two stages, the first stage comprising the burning of suitable fuel with air enriched by oxygen and mixing the resulting flue gases with steam, thereby preheating the steam to approximately the temperature of the flue gases; the second stage comprising introducing the hot mixture, without cooling, directly into the lower part of a column of incandescent solid fuel in a molten slag producer and withdrawing the resulting combustible gas from the upper part of the column.

Tunnel kiln. F. M. HARTFORD AND G. D. BRUSH (Harrop Ceramic Service Co.). U. S. 1,965,832, July 10, 1934.

Walking beam conveyer for furnaces. J. R. MOSER AND E. G. DE CORIOLIS (Surface Combustion Corp.). U. S. 1,964,297, June 26, 1934.

Geology

Barite deposits in Gottesberg, Silesia. K. SEIDL. *Metallwirtschaft*, **12** [36], 517–19 (1933).—Geological conditions and production methods are described. The mineral is of a very regular composition with a yearly output of 6000 to 10,000 tons. M.H.

Beryl in the Black Hills. FRANCIS CHURCH LINCOLN. *Eng. Mining Jour.*, **135** [5], 202–203 (1934).—Beryl, the only commercial source of beryllium, occurs in many of the pegmatite dikes and knobs which intrude the Algonkian schists of the Black Hills. It is mined as a by-product in the mining of mica, feldspar, and lithium. The present price is $35.00 per ton f.o.b. Keystone, S. D. The mines in which it occurs are listed, including eleven properties from which it has been shipped. The largest single crystal

found measures 8 ft. in diameter. Beryl ($3BeO \cdot Al_2O_3 \cdot 6SiO_2$) contains 14% BeO. It is used as a constituent of porcelain, a raw material for producing BeO for electrical refractories, a source of beryllium metal, and as a gem stone. Illustrated. J.L.G.

Story of Canadian mining. II (continued). FREDERICK EDWARDS. *Can. Mining Jour.*, **55** [6], 281–87 (1934); see *Ceram. Abs.*, **13** [7], 191 (1934). G.M.H.

BOOK REVIEW

Mineralogy of the Union. II. Zircon. E. E. KOSTYLYEVA AND M. E. VLADIMIROVA. Lomonosov's Institute of Geochemistry, Crystallography, and Mineralogy. Publishing House of Academy of Sciences of U.S.S.R., Leningrad, 1934. 83 pp., 18 figs. Price 2 R. This book is the second of a series of books published by the Academy of Sciences on minerals. In Part I are given historical data, synonyms, and classifications of zircons, their physical and chemical properties, and genesis. Part II deals with deposits of zircon in U.S.S.R., their properties and industrial uses. The Ilmen Mountains in the Ural district have the most interesting and important occurrences. The zircons of the Ilmen Mountains are noted for their beauty and extraordinary dimensions from microscopical crystals to large ones weighing 3000 g. A crystal was found weighing 3500 g. An 8-page index of more than 200 reference literature sources is given. This publication will serve as a reliable and useful book for those interested in resources of zircon and its numerous applications in the refractory, metallurgical, chemical, and other industries.

S. I. PERKAL

BOOKS AND BULLETINS

Abstracts of current articles on geophysical prospecting. F. W. LEE. *Bur. Mines Monthly Rept.*, GA 60, 23 pp.; GA 61, 25 pp. Price 10¢ each. See also *Ceram. Abs.*, **13** [8], 221 (1934). R.A.H.

Deformation of the Earth's Crust. W. H. BUCHER. 518 pp., 100 figs., 6 tables. Princeton Univ. Press, 1933. Price $5.00. Reviewed in *Econ. Geol.*, **29** [3], 309–10 (1934).—This is one of the best textbooks on structural and dynamic geology for advanced students. J.L.G.

Manganese; its occurrence, milling, and metallurgy. I. R. S. DEAN, F. D. DEVANEY, AND WILL H. COGHILL. *Bur. Mines Information Circ.*, No. 6768, 98 pp. Physical properties and preparation of metallic manganese, compounds, occurrence, and ore-dressing possibilities of ores in the U. S. are presented. **II.** C. G. MAIER. *Ibid.*, 68 pp. Thermodynamic properties of manganese and its metallurgically important compounds are discussed. M. presents a review of literature as well as original calculations for metallic manganese, oxides of manganese, sulfide, carbonate, sulfate, etc. **III.** R. S. DEAN, E. S. LEAVER, AND T. L. JOSEPH. *Ibid.*, 90 pp. The authors discuss the general metallurgy of manganese, hydrometallurgy, and pyrometallurgy. **IV.** G. R. FITTERER AND M. B. ROYER. *Ibid.*, 59 pp. Ferrous alloys of manganese and their use in the steel industry are given. **V.** M. E. WINSLOW. *Ibid.*, 47 pp. Bibliographic references cited in the first four parts of the report and indexes of the report by authors and subjects are given. R.A.H.

Study of the properties of Texas-New Mexico polyhalite relating to the extraction of potash. VIII. Removal of sodium chloride from crude polyhalite by washing. J. M. DAVISON AND F. FRAAS. *Bur. Mines Rept. of Invest.*, No. 3237, 25 pp. Free. Small-scale engineering tests have demonstrated that the sodium-chloride content may be reduced to as low as 1% with a loss under 5 lb. of K_2SO_4 per 100 lb. of sodium chloride removed when diluted waste liquors containing about 1 g. of the sulfate and 8 g. of $MgSO_4$ per 100 g. of water are used as the washing medium. For Part VII see *Ceram. Abs.*, **13** [1], 24 (1934). R.A.H.

Chemistry and Physics

Apparent solid solutions. I. A. BENRATH AND H. SCHACKMANN. *Z. anorg. allgem. Chem.*, **218** [2], 139–45 (1934).—The systems $BaSO_4$–$KMnO_4$–H_2O and $CaCO_3$–$NaNO_3$–H_2O were studied at 25°C. No solid solutions were found in the systems. The conditions for the formation of solid solution as outlined by Grimm are not fulfilled. L.T.B.

Application of statistical methods to the planning of routine testing procedure. B. P. DUDDING AND I. M. BAKER. *Jour. Soc. Glass Tech.*, **18** [69], 19–31 (1934).—This paper deals with questions raised during the discussion of a former paper (*Ceram. Abs.*, **13** [3], 59 (1934)). The factors which should be considered in deciding on the "population," the logging of test data, the number of specimens in the test sample, and the determination of rejection limits are discussed in detail.

Behavior of zirconium, thorium, and combined rare earths with quinalizarin. A. S. KOMAROVSKY AND I. M. KORENMAN. *Z. anal. Chem.*, **94** [7–8], 247–49 (1933).—A report on the color reactions obtained in solution and on filter paper with alkaline earths and quinalizarin is presented. E.J.V.

Colorimetric determination of potassium. S. N. ROSANOW AND W. A. KASARINOWA. *Z. anal. Chem.*, **96** [1–2], 26–29 (1934).—The colorimetric method of determining potassium based on the Lombard nitrite reaction gives accurate results, agreeing with those obtained by the platinic-chloride method. It requires no expensive or difficultly obtainable reagents. The color reaction obtained is constant. This method is suitable for making a series of tests on agriculturally important minerals. E.J.V.

Course of melting curves. G. TAMMANN AND G. MORITZ. *Z. anorg. allgem. Chem.*, **218** [1], 60–64 (1934).—A thermodynamical consideration of temperature-pressure relations and applications is presented. L.T.B.

Crystal lattice of boric acid (BO_3H_3). W. H. ZACHARIASEN. *Z. Krist.*, **88** [2], 150–61 (1934).—Crystals of boric acid are triclinic holohedral. The unit cell has the dimensions $a = 7.04$ Å, $b = 6.56$ Å, $c = 6.56$ Å with angles $\alpha = 92° 30'$, $\beta = 101° 10'$, $\gamma = 120°$. There are four molecules BO_3H_3 within the unit cell. The boron and oxygen positions are characterized by 24 degrees of freedom. The values of these 24 parameters were determined from the intensities observed in oscillation photographs. The location of the H parameters requires 18 further parameters.

These values were found from consideration of interatomic distances. The structure can conveniently be described as a pile of two-dimensional lattices, each having hexagonal symmetry. The layers are 3.18 Å apart and are held together by very weak bonds, thus explaining the perfect cleavage and small rigidity. Each layer is built up of BO_3 groups which are held together by H atoms. The B-O distance is 1.36 Å. Each H atom is linked to 2 oxygen atoms forming collinear groups (O-H-O) similar to hydrofluoric ion. The O-O distance in these groups is 2.71 Å. G.R.S.

Determination of calcium-ion concentration and its application for the determination of the dissociation of calcium hydroxide. GEORG KILDE. *Z. anorg. allgem. Chem.*, **218** [2], 113–28 (1934). L.T.B.

Determination of small quantities of selenium in iron pyrites. K. BRÜCKNER. *Z. anal. Chem.*, **94** [9–10], 305–22 (1933).—B. attempted to find the sources of error present in various methods used in actual practice for determining selenium in iron pyrites. There is a loss of selenium (1) on boiling with hydrochloric acid, (2) on evaporation of hydrochloric acid, nitric acid, and aqua regia solutions to dryness, and (3) on drying the residues of these three solutions in a drying oven. The difficulties which exist in the separation of selenium from nitric acid and aqua regia solutions were avoided by evaporation with sulfuric acid, the precipitation from the solution so obtained taking place smoothly. A new method for the rapid and certain determination of selenium in pyrites was worked out, in which the former sources of error are avoided. E.J.V.

Flame temperatures in carbon monoxide and air mixtures. W. T. DAVID AND J. JORDAN. *Phil. Mag.*, **17**, 172–81 (1934).—The temperatures attained by fine platinum wires in explosive mixtures of CO and air are measured over a limited range of concentrations. In mixtures at atmospheric density varying from 14 to 69% CO, a maximum temperature of about 880°C was attained at a mixture of about 28% CO. This temperature and concentration was estimated from an extension of the curves between temperature and concentration at lower temperatures. The ideal curve assuming complete combustion and taking account of dissociation gives a maximum of about 2250°C at a concentration of about 32% CO. Additional tests were made at 5 and 8 atmospheres pressure. The difference between the measured results and the ideal case is greater for the strong mixtures than for the weaker ones. The maximum temperature as measured by the explosion temperature is about the same as that attained in a Bunsen flame but is at a different mixture. No complete explanation of the discrepancy between computed and measured results is offered. Radiation loss from the flame is shown to be inadequate to account for the difference. J.T.L.

Formula to determine the direction of the extraordinary ray in a uniaxial crystal, derived by a method of analytical geometry. ROBERT V. BAUD. Presented at meeting of the American Physical Society, Cincinnati; abstracted in *Phys. Rev.*, **45** [2], 121–22 (1934).—Θ = arc tan $\dfrac{\cos\alpha - k(n_1/n_2)\sin\alpha}{\sin\alpha + k(n_2/n_1)\cos\alpha}$ where β = angle of incidence, Θ = angle between the direction of the extraordinary ray and a line perpendicular to the optic axis, α = the angle between the crystal face and the optic axis, n_1 = the index of refraction for rays perpendicular to the optic axis, n_2 = index for parallel rays, and $k = (1/\sin\beta)(n_1^2\sin^2\alpha + n_2^2\cos^2\alpha - \sin^2\beta)^{1/2}$. J.L.G.

Graphical method for obtaining the optical constants of a medium from the reflecting powers at several angles of incidence. RICHARD TOUSEY. Presented at meeting of the American Physical Society, New York; abstracted in *Phys. Rev.*, **45** [8], 562 (1934).—For a smooth surface the reflecting power, R, at any angle of incidence, i, is related by a complicated formula to the refractive index, n, and the extinction coefficient, k, for incident light of given polarization. By fitting a curve calculated from this formula to an experimental curve for R *vs.* i, n and k are determined. A graphical method for accomplishing this fitting quickly is presented. J.L.G.

Interconversion of atomic and weight percentages. J. S. MARSH. *Metals & Alloys*, **5** [3], 48 (1934).—A graphical method of interconverting atomic and weight percentages is described whereby a curve is constructed showing difference values as a function of percentage value to be converted. R.H.H.P., JR.

Melting diagram of the system ZrO_2–SiO_2. NINA ZIRNOWA. *Z. anorg. allgem. Chem.*, **218** [2], 193–200 (1934).—A maximum on the liquidus at a composition $ZrSiO_4$ showed compound formation with a melting point at 2430°C. Two eutectics and a region of solid solution limited by 10% molecular silica were found in the system. L.T.B.

Method of eliminating lens-flare from Gauss and vertical illuminators. E. E. JELLEY. *Jour. Roy. Microscop. Soc.*, **54** [1], 18–22 (1934). G.R.S.

Polymorphous transformation of calcium. A. SCHULZE AND H. SCHULTE-OVERBERG. *Metallwirtschaft*, **12** [44], 633–35 (1934).—A study of the properties of Ca at elevated temperatures revealed discontinuities in thermal expansion and electric resistance and a considerable heat of reaction in the range between 430 and 450°C which points to a polymorphous transformation at this temperature. Another bend in the resistance-temperature curve at 350° is ascribed to a recrystallization of Ca. M.H.

Preparation of pure anhydrous sodium carbonate. W. H. WITHEY. *Jour. Soc. Glass Tech.*, **18** [69], 69–70 (1934).—A process is briefly described of obtaining pure anhydrous sodium carbonate free from traces of iron oxide and therefore suitable for the determination of small amounts of iron oxide in glasses, sands, and other silicates.

Production of pure chromium. P. P. ALEXANDER. *Metals & Alloys*, **5** [2], 37–38 (1934).—Spectroscopically pure chromium was made by reducing chromic oxide by means of tantalum hydride at a temperature of 1000°C and a pressure of 1 mm. of mercury. The use of calcium hydride produced metal 99.95% pure. R.H.H.P., JR.

Pyrometric cone-equivalent values for the CaO–Al_2O_3–SiO_2 system. FRANK ZVANUT AND HEWITT WILSON. *Jour. Amer. Ceram. Soc.*, **17** [8], 255–56 (1934).

Quantitative determination of lead by picrolonic acid. F. HECHT, W. REICH-ROHRWIG, AND H. BRANTNER. *Z. anal. Chem.*, **95** [4–6], 152–63 (1933).—A new method for the determination of lead with picrolonic acid, patterned after the method for determining calcium, is presented. The new weighing form is distinguished by the low lead

content (27.25%), the easy washing as the result of the excellent crystallization properties, and by the short time in which the determination can be carried out. The method permits the determination of small amounts with considerable accuracy. It is especially suited for micro-determinations not only because of its exactness but also because of the possibility of using suitable working methods with the micro-filter cups. It permits the separation of lead from small amounts of platinum which can enter in as impurities from the platinum crucibles and platinum suction filters used in the course of a gravimetric micro-mineral analysis. E.J.V.

Quantitative microscopic determination of the quartz content of commercial ground feldspars. C. L. THOMPSON. *Jour. Amer. Ceram. Soc.*, **17** [8], 257–58 (1934).

Reactions of lime and silica in the solid state. K. HILD AND G. TROMEL. *Z. anorg. allgem. Chem.*, **215** [4], 333–44 (1933).—A study of the reaction at 1000°C of lime and silica in the molecular proportion $1CaO : 1SiO_2$ is given. The rate of reaction is greatly influenced by the size of the raw materials and the intimacy of mixing. The course of the reaction was followed by microscopic examination and by X-rays. L.T.B.

Röntgenographic investigations of calcium at elevated temperatures. L. GRAF. *Metallwirtschaft*, **12** [45], 649–53 (1933).—The irregularity at 450°C of the cooling, dilatometer, and electric-resistance curves is due to an allotropic transformation of Ca in which the cubic face-centered lattice of the α-phase (which is permanent at 20°C) changes to a cubic space-centered lattice, the β-phase, with a constant $a = 4.434$ Å. The high resistance of wires compressed at 300° is caused by 100% plastic deformation which produces disturbances in the lattice. M.H.

Sensibility to color-temperature change as a function of temperature. DEANE B. JUDD. *Jour. Opt. Soc. Amer.*, **23** [1], 7–14 (1933).—Determinations at the same brightness have been made by six observers of the color-temperature difference just doubtfully perceptible over the range of 1800 to 11,000°K. It has been found that this temperature difference corresponds closely to a constant change in the spectral centroid of light, is closely proportional to the square of the color temperature, and approximates closely a constant change in the r-coördinate of the color represented on a Maxwell color triangle. The tentative conclusion of Davis and Gibson that between 2000 and 3000°K the size of the chromaticity interval remains substantially unchanged regardless of whether the radiators be viewed directly or through a blue filter not more highly selective than an artificial daylight filter has been confirmed. Upon this basis the phenomenon of color constancy or the reason colors of objects are almost constant for illuminants differing as widely as incandescent lamplight and natural daylight is explained. R.H.H.P., JR.

Structure of epididymite ($HNaBeSi_3O_8$). T. ITO. *Z. Krist.*, **88** [2], 142–49 (1934).—The structure of epididymite ($HNaBeSi_3O_8$) was determined by X-ray analysis using oscillation photographs (CuKa and MoKa radiations and the ionization spectrometer (RhKa radiation). The space group is V_h^{16} and the unit cell has the dimensions $a = 12.63$ Å, $b = 7.32$ Å, $c = 13.58$ Å, containing 8 molecules of $HNaBeSi_3O_8$. The structure is characterized by the presence of Si_3O_8 chains stretched parallel to the b-axis. The chains are linked up into sheets, two chains holding in common one half of the oxygen atoms on their fringe. The sheets thus formed are again joined to one another by Be-OH-O chains, also stretched parallel to the b-axis. Na atoms are incorporated in the structure in such positions as to join the complex chains Si_3O_8 into sheets having the composition $NaSi_3O_7$. G.R.S.

Study of the system CaO–SiO_2–H_2O at 30°C and of the reaction of water on the anhydrous calcium silicates. E. P. FLINT AND LANSING S. WELLS. *Bur. Stand. Jour. Research*, **12** [6], 751–83 (1934); R.P. 687.—A graph has been prepared representing the solubility of silica at 30°C in solutions containing increasing concentrations of lime up to saturation, the solutions being in "equilibrium" with solid phases composed of hydrated combinations of lime and silica. An electrometric analytical study of both supersaturated and unsaturated solutions of silica at definite concentrations of lime, when correlated with these equilibrium solubility relationships, indicates the existence of definite compounds in the system CaO–SiO_2–H_2O which may be the hydrated calcium salts of orthosilicic acid. Experimental values were obtained for the hydrolysis constants of these salts from which ionization constants were calculated. A study of the reaction of water upon the anhydrous calcium silicates showed that the products formed depend upon the equilibrium relationships of the system CaO–SiO_2–H_2O. R.A.H.

Viscosities of iron slag. F. HARTMANN. *Stahl & Eisen*, **54** [22], 564–72 (1934).—Viscosities of iron slags may be arranged in the following order: mixer, blast furnace, open-hearth furnace, and Thomas slag. Interesting diagrams and data are presented. W.M.C.

X-ray study of red monoclinic selenium. Proof of the existence of two red monoclinic varieties of selenium. H. P. KLUG. *Z. Krist.*, **88** [2], 128–35 (1934).—Crystals of α and β modifications of red monoclinic Se were investigated by means of Laue and oscillation photographs and the separate identity of the β variety was proved. The unit cell of the α form contained 32 atoms Se and had the dimensions $a_0' = 8.992$ Å, $b_0' = 8.973$ Å, $c_0' = 11.52$ Å, $\beta' = 91° 34'$. The space group of the α form is probably C^2_{2h}. The β variety has a cell with the following dimensions: $a_0 = 12.74$ Å, $b_0 = 8.04$ Å, $c_0 = 9.25$ Å, $\beta = 93° 4'$. It is probable that the cell contains 32 atoms, in which case the calculated density of the β form is 4.42. Its space group is probably e^4_{2h}. The possibility of structure closely similar to that of rhombic S is pointed out, especially for the α form. G.R.S.

BOOK REVIEWS

General Properties of Matter. F. H. NEWMAN AND V. H. L. SEARLE. 2d revised ed. 380 pp., cloth. $4.00. Macmillan Co., New York, 1933. The fourteen chapters discuss (1) general principles, (2) acceleration of gravity, (3) gravitation, (4) gyroscopic motion, (5) elasticity: Articles 55 to 76, elastic bodies, Hooke's law, elastic measurements, stress and strain, moduli of elasticity, direct measurements of Young's modulus, determinaiton of Poisson's ratio, torsion of a cylinder, torsion of bars of non-circular cross-section, bending of beams, spiral springs, relations between the elastic constants of a wire, cross-

section of bent beams, bulk modulus of solids, elasticity of fluids, bulk moduli of liquids, elasticity and temperature, isothermal and adiabatic elasticities, theory of elasticity, strain ellipsoid, and bibliography (this complete synopsis of Chapter 5 indicates the thorough and detailed treatment of each); (6) surface tension, (7) viscosity, (8) kinetic theory of matter, (9) Fourier's theorem, (10) osmosis and diffusion, (11) dynamical basis including vibration, (12) equations of motion, (13) wave motion in liquids, (14) units and dimensions. See also *Ceram. Abs.*, **12** [10–11], 404 (1933).

Thermochemistry. Vol. I. I. A. KABLUKOV. State Scientific Technical Publishing House, Moscow, Leningrad, 1931. 235 pp. Price 2 R, 50 kopeks. In the first chapter the basic laws of thermodynamics, kinetic theory of gases, and the law of conservation of energy are outlined. The second chapter deals with heat capacity, heats of melting, and evaporation of bodies. The third chapter is devoted to a short historical review of the development of thermochemistry embracing the works of Lavoisier and La Place, Dulong, Depres, Hess, Favr and Silverman, Thomsen, Berthelot, Beketov, Luginin, and others. In the fourth chapter the application of the first law of thermodynamics in thermochemistry is described. The last two chapters deal with heats of solution, neutralization, and the heat of combustion and formation of organic compounds. In the appendix problems for calculating the heat of chemical reactions are given. K.'s main purpose was not only to give thermochemical data but to acquaint the reader with the methods of applying the laws of thermochemistry to the calculation of the heats of different chemical reactions. In general it is a fundamental book written on a strictly scientific basis.

S. I. PERKAL

BOOKS

Annual Reports on the Progress of Chemistry for 1933. Vol. 30. 462 pp. Chemical Society, London, 1934. Price 10s 6d. Briefly reviewed in *Nature*, **133** [3367], 707 (1934).—The reports for 1933 deal with general and physical, inorganic, organic, and analytical chemistry, biochemistry, radioactivity and subatomic phenomena, and crystallography. They form a valuable source of information on recent progress. J.L.G.

Ternary Systems (Ternäre Systeme). G. MASSING. Akademische Verlagsges., Leipzig. 164 pp. Price 9.60 Rm. Reviewed in *Verre & Silicates Ind.*, **5** [6], 114 (1934).—M. gives a clear elementary review of the ternary systems. Although it seems to be applied primarily to metallic alloys, this work presents a considerable and evident value for the silicate science in which ternary systems are so often found, much more than in metallurgy. M.V.K.

Text-Book of Chemistry. H. A. WOOTTON AND C. W. R. HOOKER. xii + 488 pp. Cambridge Univ. Press, 1933. 6s. Briefly reviewed in *Nature*, **133** [3366], 667 (1934).—The book is a general elementary chemistry. Illustrated. J.L.G.

Textbook of Inorganic Chemistry. FRITZ EPHRAIM. English ed. by P. C. L. THORNE. 2nd ed., revised and enlarged. xii + 873 pp. Gurney and Jackson, London, 1934. Price 28s net. Briefly reviewed in *Nature*, **133** [3366], 668 (1934).—A textbook of the nonmetals for students who have already a groundwork in chemistry. J.L.G.

Textbook of Inorganic Chemistry: for University Students. J. R. PARTINGTON. 4th ed. viii + 1062 pp. Macmillan Co., Ltd., London, 1933. Price 15s net. Briefly reviewed in *Nature*, **133** [3368], 741–42 (1934).—The previous edition is brought up to date by extensive revision and addition. A valuable reference work for advanced students. J.L.G.

PATENTS

Bonded article and method of bonding. E. L. HAUMAN (Exolon Co.). U. S. 1,966,408, July 10, 1934. As a bond for bonding the relatively large, well-defined, freely developed alpha corundum crystals which were developed *in situ* in it, a ground portion of the unstable glass in which a preponderance of such crystals were developed as a matrix, the glass being present in sufficient amount to have provided for the free growth of the corundum crystals, and the mass of glass and crystals resulting from the fusion and cooling of a mix consisting of from 60 to 86 parts of alumina to 40 to 14 parts of silica together with an absorption-prevention oxide of the group composed of alkaline earth and alkali-metal oxides in sufficient amount to extend the period of corundum crystallization during cooling of the melt and to shorten or eliminate the later period of mullite development, the glassy matrix has the property of forming mullite and a stable clear glass on heating to ordinary bonding temperatures and consists of the residual alumina, silica, and absorption-prevention oxide which constituted the mix and is rich in alumina.

Corundum product and process of producing. E. L. HAUMAN (Exolon Co.). U. S. 1,966,407, July 10, 1934. As a new composition of matter, a mass consists of a glassy matrix containing a preponderance of alpha corundum crystals without mullite in appreciable quantity, the mass resulting from the fusion and cooling of a mix consisting of from 60 to 86 parts of alumina to 40 to 14 parts of silica together with an oxide of the group composed of alkaline earth and alkali-metal oxides in sufficient amount to extend the period of corundum crystallization during cooling of the melt and to shorten or eliminate the later period of mullite development, the corundum crystals being relatively large as to size, platy as to form, and well defined and freely developed as to structure, and the glassy matrix being present in sufficient amount to have provided for such free growth of the crystals and being an unstable glass rich in alumina and having the property of forming mullite and a stable clear glass on heating to ordinary bonding temperatures.

Euhedral corundum crystal. E. L. HAUMANN (Exolon Co.). U. S. 1,966,406, July 10, 1934. The process consists in fusing a mixture of alumina, silica, and magnesia in such proportions as to yield on solidification a preponderance of alpha corundum of euhedral crystalline characteristics in a glassy matrix, the proportions being approximately 3 parts alumina to 1 part silica with magnesia addition approximately 5% of the batch.

Manufacture of pigments. G. F. A. STUTZ (N. J. Zinc Co.). U. S. 1,963,566, June 19, 1934. The improvement in the method of making, by wet chemical precipitation, a

pigment containing zinc sulfide and requiring heat treatment for imparting adequate pigment properties thereto comprises carrying out the precipitation of the pigment at a temperature substantially in excess of 100°C and under a pressure of at least 200 lb./sq. in.

Method of producing chromates. J. B. CARPENTER, JR., AND E. P. STEVENSON (Arthur D. Little, Inc.). U. S. 1,964,719, July 3, 1934.

Process and apparatus for the production of barium oxide. KALI-CHEMIE A.-G. Brit. 411,402, June 13, 1934.

Process and apparatus for the treatment of boron minerals. BORAX CONSOLIDATED, LTD. Brit. 412,511, July 4, 1934.

Process for making pigments. H. A. DEPEW (American Zinc, Lead & Smelting Co.). U. S. 1,963,546, June 19, 1934.

Process for the preparation of pure beryllium compounds. WALTER ZISCH AND GUSTAV JAEGER (Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler). U. S. 1,966,371, July 10, 1934. A process for the preparation of pure beryllium compounds from materials containing, in addition, alumina and silicic acid consists in converting the beryllium present into beryllium oxide insoluble in dilute acid, treating the reaction product with a dilute acid which is capable of forming soluble salts with ammonia alkaline earths and iron, separating the solution from undissolved silica and beryllium oxide, and separating the two latter compounds.

Process of producing crystalline anhydrous borax. L. G. BLACK (American Potash & Chemical Corp.). U. S. 1,964,902, July 3, 1934.

General

American Standards Association symbols for fluid measurements. ANON. *Bull. Amer. Ceram. Soc.*, **13** [7], 190–92 (1934).

Colloidal slurry, a new bonding material. KRAUS RESEARCH LABORATORY. *Ceram. Ind.*, **22** [7], 392 (1934).—Colloidal slurry is made by digesting halloysite in the presence of a small percentage of asphalt base oil. It is claimed that colloidal slurry improves plasticity, acts as a lubricant for extruded ware, makes cast ware stronger, does not reduce the melting point, extends the vitrification range, improves firing behavior, reduces the cost of bonding agents, acts as a fixative in ceramic bodies, gives a better structure to fired bodies, adds great strength to both raw and fired bodies, is not glassforming at high temperatures, has a low water dispersion, influences the uniformity of mixes, and reduces the amount of bond necessary in mixes. E.J.V.

Practical clayworking. XIII. ANON. *Brit. Clayworker*, **43** [505], 33–35 (1934).—A continuation of a discussion on humidity driers with special reference to the Keller drier is given. For Parts XI–XII see *Ceram. Abs.*, **13** [8], 217 (1934). R.A.H.

Silicosis. W. R. JONES. *Bull. Inst. Mining Met.*, No. 352, pp. 1–42 (1934); abstracted in *Analyst*, **59**, 191–92 (1934); see also *Ceram. Abs.*, **13** [8], 227 (1934). H.H.S.

Silicosis in the pottery industry in Denmark. Examination of workers in Danish pottery factories. S. V. GUDJONSSON. *Arch. Gewerbepath. & Gewerbehyg.*, **4**, 748–71 (1933); abstracted in *Jour. Ind. Hyg. Abs.*, **16** [3], 58–59 (1934).—X-ray photography carried out on 798 workers provided the data upon which conclusions are based in this investigation. No distinction is drawn between earthenware and china in the making of which the exposure to flint dust is entirely different. No dust estimations were made regarding either the amount of dust, its composition, or the size of particles. G. considered he found signs of silicosis in 58.6% of the 461 men examined, and in 27.3% of the 337 women, but he states that the wet processes (which should be dust free) seem to be just as dangerous as the dry. The incidence of illness for all the workers was high, while respiratory diseases were especially frequent among those having silicosis. Out of 46 deceased potters 21 died from some form of respiratory disease. Although active cases of tuberculosis were found among silicotics in an advanced stage, the occurrence of tuberculosis was not frequent. E.J.V.

Sodium silicate: increasing uses in the ceramic industries. J. G. VAIL. *Chem. Trade Jour.*, **94** [2446], 249–59 (1934). M.V.K.

BOOK REVIEW

Pneumonokonioses (Silicosis): Bibliography and Laws. GEORGE G. DAVIS, ELLA M. SALMONSEN, AND JOSEPH L. EARLYWINE. Foreword by E. R. Le Count. Published by Industrial Medicine, Inc. 482 pp. Cloth, $7.50. An exhaustive compilation of the references to the pneumonokonioses (silicosis) in the literature of the world, this book contains every available reference from the first published in Agricola's "De re Metallica" in 1556 to the last published articles in 1933. The authors, George G. Davis, M.D., Associate Clinical Professor of Surgery, Rush Medical College, University of Chicago, Ella M. Salmonsen, Medical Reference Librarian, John Crerar Library, and Joseph L. Earlywine, Attorney, give authority to the work by their standing in their respective fields. The book has two sections, the first, the bibliography, is followed by subject index, author index, a reference-year index, and an index of reference headings. The second part, the law, contains a summary of the occupational disease laws, workmen's compensation laws, and common laws of the states of the United States with decisions as they relate to pneumonokonioses (silicosis). The law summary is followed by an index of states and an alphabetical index of cases. The book is exhaustively cross-indexed. Supplemental volumes are planned for successive years, the first to appear soon after January 1, 1935. Industrial executives, industrial boards, state commissions, engineers, and research workers will find this book indispensable.

HENRY H. SMITH

PATENT

Method of calcining diatomaceous earth. MCKINLEY STOCKTON (Dicalite Co.). U. S. 1,966,362 and 1,966,363 July 10, 1934.